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Vol. LXX

DECEMBER, 1919

No. 6

ANNALS of SURGERY

A Monthly Review of Surgical Science and Practice

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ANNALS *of* SURGERY

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FURTHER OBSERVATIONS ON THE CONSERVATIVE TREATMENT OF SARCOMA OF THE LONG BONES *

BY WILLIAM B. COLEY, M.D.
OF NEW YORK, N. Y.

THE present paper consists chiefly of a report of the cases of sarcoma of the long bones that have come under my personal observation during the past five years, with a brief review of cases previously published.

In a previous paper on this subject I have strongly advocated the conservative treatment of sarcoma of the long bones, and the cases observed during the past years, I believe, furnish further evidence in justification of conservative treatment. It might seem unnecessary to present this evidence, were it not for the fact that the majority of surgeons at the present time, including many men with wide surgical experience, have not fully accepted the principles of conservative treatment, and are now sacrificing many limbs which might be saved under conservative treatment.

In a paper read before the Southern Surgical Association in December, 1917, I published 200 cases of sarcoma of the long bones personally observed. Since that time 50 cases have come under my observation.

In the former papers I have discussed at considerable length the question of diagnosis. In the present paper I only wish to emphasize certain points which, larger experience has convinced me, deserve special note.

First, the element of pain. Pain, especially of a deep boring character, steadily increasing in severity, is often one of the earliest and most important signs of sarcoma of the long bones. Many of these patients are first treated for some rheumatic condition, until the disease has progressed sufficiently to produce a palpable tumor. Persistent pain is often present for weeks or months before there is a palpable tumor or the X-ray discloses any evidence of a new growth.

Pain is a more important symptom in periosteal growths than in the central tumors. The latter often attain considerable size, with little or no pain. I recently had under observation a case of periosteal sarcoma of the upper portion of the femur, in which severe pain was not only the earliest symptom, but required quite large doses of morphine before a swelling could be detected. Later on, a slight swelling was noticed in the outer aspect of the left femur, just over the trochanter. The X-ray

* Read before the American Surgical Association, June 16, 1919.

at this time showed a slight thickening of the periosteum which, in conjunction with the clinical symptoms, made the diagnosis of periosteal sarcoma probable. Under the toxin treatment alone, the pain ceased almost immediately; later a local application of massive doses of radium was made. Four weeks later the pain returned and increased in severity. An exploratory operation was done, showing an extension of the disease downward and marked involvement of the periosteum, of the extent of which the X-ray examination had given little evidence. The tumor apparently started in the under-layers of the periosteal covering of the bone, causing some roughening of the bone and great tension of the periosteum, which easily explained the agonizing character of the pain, since a condition was present not unlike a subperiosteal abscess, which produces such excruciating pain. The periosteal tumor in some places began to infiltrate the overlying muscle and fascia. A considerable portion of this tissue was removed; macroscopically it was perfectly characteristic of sarcoma. In fact, with the clinical history and macroscopical appearance, one could easily make a positive diagnosis of sarcoma. In spite of this the tissue removed for microscopical diagnosis did not show any characteristic tumor tissue, so that Doctor Ewing stated that he could not make a diagnosis of sarcoma. If the patient had continued to improve and made a complete recovery, there would always have been some doubt as to the diagnosis. A few weeks later another exploratory operation was performed in order to facilitate the use of bare tubes of radium. This time some of the tumor tissue was removed and examined microscopically. The histological structure was that of a typical small round-celled sarcoma. In very far advanced cases, the clinical signs, combined with the X-ray picture, may be sufficiently clear to definitely establish the diagnosis, and too much weight should not be given to a negative pathological report upon a specimen removed.

I still believe that in cases in which there is any reasonable doubt of the diagnosis, the advantages of an exploratory operation greatly outweigh the disadvantages. If the tumor is a periosteal sarcoma, it is extremely important to make the earliest possible diagnosis. It would certainly be unwise to sacrifice the limb, without a positive diagnosis, and it would be equally unwise to subject the patient to the discomforts of prolonged toxin or radium treatment, unless the diagnosis was reasonably certain. In the great majority of cases the clinical signs, confirmed by X-ray pictures, render the diagnosis practically certain. If the disease is far advanced, there will be no doubt. Even in these cases, particularly in tumors of central origin, it may be wise to make an exploratory incision, remove as much as possible of the tumor tissue and, in the central tumors, curetting to bare bone in order to facilitate the use of conservative methods, particularly the introduction of bare tubes of radium into the cavity. The histological type of tumor found may give us great help in making a prognosis.

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The danger of metastases resulting from such exploratory operations is, I believe, extremely slight, and the advantage of knowing exactly the type of tumor one is dealing with, far outweighs the risk.

Giant-celled Sarcoma or "Giant-celled Tumors."—Great confusion has long existed in regard to the malignancy of the so-called giant-celled sarcoma of the long bones. Within the last few years several admirable papers have been published throwing much light upon this difficult subject, the most important of which are the contributions of Platou, of Christiania (ANNALS OF SURGERY, March, 1918), and Bloodgood (ANNALS OF SURGERY, April, 1919). Bloodgood reports 47 cases of benign giant-celled tumors (43 of the long bones) in which the ordinary features of malignancy were absent. A study of these cases has induced Doctor Bloodgood to make a repeated and even stronger plea than hitherto in favor of conservative treatment of these conditions.

My own experience, based upon a study of 250 cases of sarcoma of the long bones, would justify me in going even further than Bloodgood, and I would urge the employment of conservative methods, not only to benign giant-celled tumors, osteitis fibrosa and the like, but to actual sarcomas of the long bones, both of central and periosteal origin.

Platou, of Christiania, bases his paper on a histological study of nine cases that have come under his observation, and which he has reported in full.

He takes the position that the so-called giant-celled sarcoma is not a malignant tumor at all, but is properly classed as "giant-celled tumor." Although he states that the microscopic picture, which he describes in detail, usually shows a peculiar structure which is easily recognized, he further states that it is not possible to give any decisive distinguishing features between sarcoma and giant-cell tumor. According to Platou, "if the resorption of the osseous substances can be shown to take place in connective tissue with few cells (if, in other words, fibrous marrow is found), then that fact would indicate that the bone-destroying process is not of a malignant character." He adds, "The most striking feature of the disease is the enormous giant-cells with 50 to 100 nuclei in one cell. The picture on the whole shows a varied structure with regions rich in cells and bands of connective tissue, often showing hyaline degeneration; between them every variety merging into tumor-like tissue, also bone substance in the process of formation, resorption, and once in a while islands of cartilage. The cells are mainly round or oval, their protoplasm most often clear and well defined in outline; frequently no intercellular substance can be traced.

"On the other hand, a giant-cell sarcoma under the microscope shows a more homogeneous tissue, with no such extensive spots where cells are few. The shape of the cells is more like a spindle, the intercellular substance more abundant, and besides the giant-cells we find all intervening stages down to cells with 2 to 4 nuclei—a thing rarely seen in the case of

giant-cell tumor. We have been told that if giant-cells are seen in clusters this fact would be an indication that the tumor tissue is part of osteitis fibrosa, whereas in the case of sarcoma the giant-cells would be more evenly distributed throughout the tissue."

Platou's series of 9 cases further confirms the opinion long held by Bloodgood and others that a certain number of giant-cell tumors of the long bones, particularly of the tibia, are benign in character, and while easily cured by conservative operation, the limb should seldom, if ever, be subjected to amputation.

Platou after a careful study of his own cases and those reported in the literature has reached the following conclusions:

"It is deplorable that microscopical examination sometimes permits only a probable diagnosis. The interpretation of the preparation in question will always depend on a personal opinion. There has not yet been discovered any test whereby the diagnosis may become absolutely certain either way when the cases are doubtful.

"The operator, therefore, must take upon himself the responsibility of deciding whether to take the usual consequence of a diagnosis of sarcoma, when he is aware of the fact that the original disease may be osteitis fibrosa, or whether the clinical facts of the case justify a conservative treatment—nay, even demand it."

This is practically the position which I personally have held for a long time, although I believe that resection and transplantation of bone are seldom necessary.

If we could always be sure we were dealing with a benign giant-celled tumor of the long bone, such as Bloodgood describes, simple curetting, which he advocates, or in more advanced cases, resection, would suffice. But we must admit that in many instances it is difficult to determine whether a case in question is a giant-celled tumor of benign type, or an actual sarcoma with malignant features. In my own list of giant-celled sarcomas of the long bones, 40 in number, the diagnosis of giant-celled sarcoma was made by a number of leading pathologists. Yet the fact that out of these 40 cases 8 died of metastases proves that in certain cases, at least, the tumor was of a very different type from that described by Bloodgood and Platou.

Perhaps in the light of more recent study of these tumors it may be possible to differentiate, in a larger number of cases, the malignant giant-celled tumors from the benign. But at the present time, we must admit there are few that are able to make the distinction positively.

That the myelogenous or mixed giant-celled sarcomas, particularly of the lower end of the femur, are, for the most part, true malignant tumors, is well brought out by the statistics of the Bruns Clinic, reported by Kocher in the *Beitr. f. klin. Chir.*, 1906, Bd. 50, Hft. 1, p. 118. In 33 consecutive cases of central myelogenous sarcoma, 4 were too far advanced for amputation or the patient refused it (it is assumed that these ended fatally); of

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11 cases in which amputation was performed, 1 died of the operation, 8 died of metastases, and only 2 were known to have been well beyond the three-year period. As no microscopic sections were published it is impossible to state how many were of the "giant-celled type" described by Bloodgood and Platou. If none were of this type it only confirms my own opinion that the benign giant-celled tumor of the femur is comparatively rare, especially when accompanied by the clinical signs of malignancy, rapid growth and extensive invasion of the surrounding tissues, especially the knee-joint.

My own series of cases shows that in a small number of cases of periosteal and highly malignant tumors of the long bones, the limb as well as the life of the patient can be saved by the prolonged use of the mixed toxins of erysipelas and bacillus prodigiosus, and even a larger number of cases with tumors of central origin of unmistakably malignant type, can likewise be saved.

If the tumor appears almost certainly benign, curetting alone will probably prove sufficient to effect a cure, but my own experience, covering 250 cases of sarcoma of the long bones, with 40 of the giant-celled type, shows that this type of tumor of the long bones is comparatively rare. I should hesitate to place complete reliance on the microscopical examination alone, unless fully supported by the clinical history and the X-ray pictures. Bloodgood's report of 43 cases of benign giant-celled tumors of the long bones, gives one, I think, a mistaken impression of the relative frequency of the condition—an impression which might be corrected by remembering that Bloodgood's interest in this subject dates back many years and his frequent reports of cases have influenced surgeons all over the country, to send him special cases, resulting in his being able to report a personal observation of 43 cases of what may still be regarded as a comparatively rare type of tumor.

In dealing with periosteal tumors we have an entirely different proposition. Here there is no longer any doubt about the malignancy of the tumor, and all agree that even the most radical operation rarely saves the life of the patient. The hopelessness of the condition warrants us in trying almost any method of treatment that offers the slightest prospect of saving the limb, and this very hopelessness justifies us, I believe, in making an exploratory operation in order to definitely establish the diagnosis at the earliest moment. The microscopical diagnosis of periosteal sarcoma is, in most cases, much less difficult than in the tumors of central origin, but in certain rare cases one also encounters similar difficulties. In a few cases it may be entirely impossible to make a positive diagnosis (histologically), yet the clinical history and physical signs leave little doubt that we are dealing with a periosteal sarcoma. Formerly I advised amputation in these advanced periosteal cases, until I found that in a number of cases in which the patients absolutely refused amputation I was able to save the limb as well as the life of the patient by the use of

the mixed toxins. In one of these cases recovery took place after metastases had developed.

The result in these cases, I believe, justifies us in treating even periosteal sarcomas by conservative methods. The question naturally arises: should we limit the treatment to the mixed toxins or to radium alone, or a combination of both. We know that the toxins, without any other agents, have cured the disease, saved the limb, and the patients have remained well for many years afterward. This is true of every type of sarcoma, both periosteal and central. As far as I know, few cases have been cured by radium alone. The only case reported in which the patient remained well five years, is that of Pinch of the London Radium Institute, 1918. No details of the case, however, have so far been published, nor do we know the nature of the histological structure of the tumor.

I have had under observation a case of periosteal sarcoma of the femur which failed to improve under a month's toxin treatment, and I then advised amputation followed by toxins. The patient later placed himself under the care of the late Dr. Joseph Bissell, who gave him repeated radium treatments. The tumor apparently disappeared and he remained well nearly two years, when he had a local recurrence which was not controlled with massive doses of radium. I then amputated below the trochanter, but lung metastases soon developed, and spinal metastases, causing death in a few months.

We have had two cases at the Memorial Hospital during the last year in which the tumors have apparently disappeared under the use of radium alone. One was a large tumor of the upper end of the humerus, pronounced chondroma from tissue removed at exploratory operation, but in view of the large size and rather rapid growth it was believed by Doctor Ewing to be chondrosarcoma. This tumor showed remarkable disappearance under radium treatment administered by Doctor Janeway, in the form of bare tubes introduced into the tumor substance, supplemented by massive doses of radium in the form of a pack. The sinus, however, persisted, and an examination of a recent curetting in May, 1919, showed the presence of a "degenerating chondrosarcoma." No active chondrosarcoma was found in this curetted material but only broken-down fragments of necrotic tumor tissue. The other case was a small giant-celled sarcoma of the upper end of the tibia which is still well a little less than one year. In view of these results it would seem that the interest of a patient suffering from sarcoma of the long bones may be best served by giving him the benefit of combined treatment, *i.e.*, the systemic effect of the toxins with the local action of radium. If the tumor does not show marked improvement in the course of four or five weeks under this treatment, I would advise amputation followed by the use of the toxins as a prophylactic against recurrence, that is, if the disease is not too far advanced for amputation.

Resection with or without bone implantation is, I believe, seldom indi-

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cated. The cases I have reported in full, especially the tibia case with complete destruction of the upper five inches of the tibia, treated conservatively by curetting, toxins and radium, with almost complete restoration of the destroyed bone and the patient well nearly four years, shows how much Nature can do if the sarcoma has been completely controlled.

It is difficult to estimate the definite percentage of cases in which one may succeed in saving the life and limb in sarcoma of the long bones. It depends largely upon the stage of the disease at the time conservative treatment is begun; the percentage will be much higher in the cases treated at an early stage than in those treated at a later stage.

Nevertheless, my series of cases shows several cures in which the disease was so far advanced as to be entirely beyond hip-joint amputation. These cases show that few, if any, should be regarded as so desperate as not to warrant an attempt to save the limb as well as the patient's life. In a very large number of my cases the disease has been too far advanced for amputation, so that this series does not give a fair idea of the results which might have been obtained had the disease been treated at an earlier stage. However, they give some idea as to the number of recoveries that may be looked for in advanced cases. If we are able to cure a considerable number of patients with the disease too far advanced for amputation, we certainly have a right to expect a much larger number of recoveries in cases seen and treated in the early stages of the disease.

As the earlier cases have already been reported before the Southern Surgical Association, I think it may be of interest to give a brief analysis of the cases treated within the last five years. During this period I have had under treatment 60 long-bone cases, classified as follows: Femur, 32; humerus, 14; tibia, 9; fibula, 3; clavicle, 2. Of the 32 femur cases, amputation was performed in 13 cases after conservative treatment had failed (there was no mortality from operation); in 4, amputation was strongly advised but refused by the patient. Eleven of these patients are still living, 2 being recent cases still under treatment, with a reasonable prospect of saving the limb. One of the patients who refused amputation had a large central sarcoma of the lower end of the femur, which was treated with toxins and radium, with slight temporary improvement; metastases later developed in the lung and the patient lived but a few weeks. One periosteal sarcoma had toxins followed by amputation; well three years when a recurrence developed. One central sarcoma of the lower end of the femur with extensive involvement of the knee-joint, refused amputation, and recovered under the toxins alone; well five years. One extensive sarcoma of the lower end of the femur involving the knee-joint and upper end of tibia, in which amputation was refused, was treated with toxins supplemented by radium, and is well now three years, walking without support of any kind. One very large inoperable sarcoma of the upper half of the femur, quite beyond hip-joint amputation, recovered under toxins and radium and is well at present without any evidence of

the disease two years later. Two cases of periosteal sarcoma of the femur treated with radium and toxins during the last six months in the hope of saving the limb, result still doubtful. In three cases of sarcoma of the femur, amputation was performed followed by the use of the mixed toxins as a prophylactic against recurrence; two cases are still well three years later, and the third died of metastasis nearly three years after amputation.

NOTE.—Recurrence has taken place in one of these cases in October, 1919.

Following is a brief report of cases containing points of special interest:

Cases I and II have been reported in Transactions of New York Surgical Society with microphotographs of tumors in ANNALS OF SURGERY, March, 1917.

CASE I.—*Central Sarcoma of the Lower End of the Femur with Extensive Involvement of the Knee-Joint, Successfully Treated with the Mixed Toxins.* L. G., female, twenty-one years of age, was first seen in consultation with Dr. V. P. Gibney, at the Hospital for Ruptured and Crippled, in October, 1914. Family history negative, Wassermann negative; no history of antecedent trauma.

Eight months previously patient first noticed pain in the left knee, while walking up and down stairs. This gradually increased in severity and shortly after was present even while walking on level surfaces. She consulted a physician who made a diagnosis of tubercular disease and applied Buck's extension to the knee, with slight temporary relief. A little later she entered a hospital where a plaster-of-Paris splint was applied, which she wore for five weeks. No improvement was noticed; thereupon several teeth were removed, on the ground that she was suffering from osteoarthritis due to pyorrhœa. Later on she was placed upon specific treatment. In spite of these widely varied therapeutic measures, the swelling and pain increased, and the patient was unable to bear the weight of her body upon the limb. She was admitted to the Hospital for Ruptured and Crippled (Doctor Gibney's service) on October 24, 1914, at which time physical examination showed general condition good; heart and lungs normal, patient wearing a plaster splint. She had lost considerable in weight. There was marked swelling and infiltration of the whole lower end of the left thigh and anterior aspect of the left knee. The knee was completely extended, with very greatly increased abnormal lateral motion, showing destruction or extreme laxity of the tissues. There was marked infiltration of the popliteal space, and moderate atrophy of the limb.

Measurements.—Left, 15, 15½, 12; right, 14¼, 14, 12.

The X-ray showed very marked expansion of the lower extremity of the femur; cortical substance thin and apparently on the point of breaking through; structure of bone has disappeared.

In view of the extensive involvement of the knee-joint, accompanied with great tenderness and extreme mobility, after careful examination and study of the X-ray plates, I concluded that the

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disease was undoubtedly a central sarcoma which had pierced the cartilage of the joint, causing joint involvement and effusion. This condition is extremely rare and I had never, up to that time, seen a case similar to it with such extensive joint involvement. Doctor Gibney and Doctor Whitman also believed the condition to be sarcoma. All of us considered it too far advanced to justify conservative treatment, and strongly urged immediate amputation. This, however, was refused by the patient and her family. On November 6, 1914, an exploratory operation was made to obtain a piece for microscopic examination. On cutting down to the periosteum, a mass was found which occupied the entire lower end of the femur, the central portion of which was greatly expanded and occupied by a tumor having the typical clinical appearance of a sarcoma. It was quite vascular and penetrated into the joint; there was considerable effusion in the joint. As much of the tumor as possible was curetted and the wound packed. Hemorrhage, which was severe, was fairly well controlled with tight packing, and the limb was put in a plaster-of-Paris splint. After microscopical examination Dr. F. M. Jeffries reported it as a "mixed-celled sarcoma."

A further examination was made by Dr. J. Ewing, who reported as follows:

The material consists of several broken portions of tumor tissue, each about 1 cm. in diameter.

On section the masses are composed of dense fibrous tissue, in many places hyaline, covered with a fringe of sarcomatous tissue of the type of giant-cell sarcoma. The giant cells are of the epulis type. There are a few trabeculae of bone which are separated by spindle tumor cells and are undergoing absorption. In several places the dense fibrous tissue is infiltrated by strands of tumor tissue in which the cells are spindle in form, with slightly hyperchromatic nuclei, but without admixture of giant-cells.

In the absence of full data regarding the anatomy of the tumor and its clinical course, it is impossible to give any positive opinion of the clinical malignancy of the case. The giant-cell areas belong in a group which generally pursues a benign course. The spindle-cell areas seem to possess greater growth capacity.

X-ray examination, November 11, 1914, showed an attempt at formation of a new joint; shaft of femur resting on the outer articular surface of the tibia. Over the inner articular, to correspond with the inner condyle, is new bone formation, making a contour of a fairly good joint; no ankylosis between femur and tibia. Lateral view shows new bone formation, anterior to the patella; appears to be some ankylosis with the patella; no evidence of metastasis.

A few days after the exploratory operation the patient was put upon the mixed toxins of erysipelas and bacillus prodigiosus, and the doses were carried up to the point of giving a severe reaction. The toxins were begun on November 11, one minim, and increased daily by $\frac{1}{2}$ minim, until December 27, when $8\frac{1}{2}$ minims (the highest dose) was reached, which produced a temperature of 104° . After this, a short interval of one week's rest was given; the toxins were

then resumed, and kept up for one year with occasional brief periods of rest, seventy-three injections in all being given.

On December 2, 1915, Doctor Gibney reported that there was no deformity; the limb was straight with little, if any, motion. Two days later, December 4, the patient was discharged from the Hospital for Ruptured and Crippled wearing a brace on the right leg.

Inasmuch as the sinus had failed to heal the patient was given an anæsthetic and through-and-through drainage was established; curettings carefully examined by Doctor Ewing failed to show any evidence of malignancy. Rubber tubes were inserted and kept in for a number of months.

Patient was readmitted to the Hospital for Ruptured and Crippled on March 7, 1916, for infection of the old sinus. Just before admission, she developed pain and slight fever. Examination revealed what was apparently an inflammatory enlargement of the knee with a boggy swelling of the popliteal region. These symptoms continued and later fluctuation developed. In March, under local anæsthesia, an incision was made in the popliteal opening and a small abscess was found which apparently communicated with the old sinuses. One of these was opened and curetted and both openings were drained. Examination of curettings again failed to show evidence of malignancy. She was shortly treated with "Dakin's fluid" and rapid healing followed. The toxin treatment was resumed for a brief period.

The patient was shown before the New York Surgical Society in November 22, 1916, and again in January, 1919. She was also presented at the meeting of the American Surgical Association on June 16, 1919, at which time she was in good health with no trace of a recurrence, over four years later. She has $2\frac{1}{2}$ inches of shortening and walks with a brace, without crutch or cane. (She is still well October 25, 1919.)

CASE II.—Extensive Sarcoma of the Upper End of the Tibia Involving the Fibula. C. M., female, seventeen years of age, was admitted to the Hospital for Ruptured and Crippled on July 22, 1915, with a history of having first noticed trouble in the upper part of the right leg, just below the knee-joint, six months prior to her admission. This consisted of a small swelling on the inner side of the upper portion of the right tibia, slight amount of pain, increasing disability, and moderate loss of weight; no enlargement of glands in the groin. At the time of her admission to the hospital she presented a symmetrical enlargement of the whole upper portion of the right leg, most marked below the patella. The limb could be flexed to about a right angle; no muscular spasm. Over the inner portion, the tumor was extremely soft on palpation, having the "feel" of semi-fluctuation.

Measurements.—Right, $11\frac{1}{2}$, 12, $12\frac{3}{4}$; left, $11\frac{1}{2}$, $11\frac{5}{8}$, $11\frac{1}{2}$, $10\frac{3}{4}$. X-ray showed a tumor involving the entire upper extremity of the tibia, the bony structure of which was practically destroyed except on the outer and upper aspect; other bones not

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affected. The disease was so extensive that amputation was strongly advised, but refused by the patient. In view of the successful results obtained with the toxins in the case of sarcoma of the femur, already detailed in this paper, conservative treatment was advised in the present case, *i.e.*, curetting for a microscopical section, to be followed by toxin treatment. In this opinion Doctor Gibney concurred.

On August 2, 1915, a four-inch vertical incision was made below the knee. The tumor was curetted out, and found to involve the whole upper part of the tibia for a distance of four inches, and nearly the same length of the fibula, with the exception of the outer wall; a thin layer of cartilage which was perforated in curetting was all that was left of the upper end of the tibia. The wound was packed with gauze, and a roller bandage tightly applied and the limb put up in plaster-of-Paris before removing the tourniquet. Pathological examination was made by Dr. F. M. Jeffries (pathologist to the Hospital for Ruptured and Crippled), who reported the tumor to be "giant-celled sarcoma."

Dr. James Ewing also examined a section microscopically and reported: "Tissue composed of typical giant-cell sarcoma of epulis type and of very moderate malignancy."

A third examination was made by Dr. George Barrie, of the Post-Graduate Hospital, who pronounced it "fibrosarcoma with giant-cells." He stated it was a true sarcoma and not a benign tumor. The clinical history of rapid development and extensive involvement and recurrence after operation furnish sufficient evidence of the malignant nature of the tumor. Blood examination August 10, 1915: Red blood-cells, 4,700,000; hæmoglobin, 85 per cent.

Four days after curetting, the patient was put upon small doses of the mixed toxins of erysipelas and bacillus prodigiosus (no other treatment). The initial dose, $\frac{1}{2}$ minim, was increased daily, by $\frac{1}{2}$ minim, until a decided reaction temperature of 102° , 103° , 104° was obtained, after which four injections a week were given.

The cavity gradually filled up with healthy granulations, and a note by Dr. V. P. Gibney, dated November 15, 1915, reads: "Open sinus over inner head of tibia; no infiltration about knee. Small range of motion allowed, not fully tested. General condition excellent. On high road to recovery."

The leg and thigh were kept in a plaster splint and the sinus treated through a window in the splint. By December 1 the sinus had closed and there was no evidence of any tumor either by physical or X-ray examination. X-ray pictures were taken regularly every two weeks. Marked new formation of bone could be noticed in the upper end of the tibia, which was completely destroyed at the time of operation. The patient also gained in weight and strength. On December 27, 1915, she was shown before the Alumni Association of the Hospital for Ruptured and Crippled, at which time there was no evidence of any lesion present.

On January 9, 1916, the patient suffered from an attack of grippe and the toxin treatment was discontinued for two weeks. On January 26, the plaster cast was removed and a recurrent tumor the size of a pullet's egg was found at the upper and inner end of the right tibia, at the site of the old sinus. An X-ray picture also showed the growth. The toxin treatment was again administered and given both locally and systemically. The tumor diminished somewhat in size but did not disappear, and on March 3, 1916, a portion of the growth about the size of a hen's egg was removed by curette and the wound was packed. A microscopical examination of the mass removed was made by Doctor Ewing, who pronounced it "giant-cell sarcoma." Blood examination, March 5, 1916: Red blood-cells, 4,856,000; white blood-cells, 7800; hæmoglobin, 82 per cent.

On March 10, 100 mg. of radium emanations were applied over the site of the tumor, and allowed to remain for twenty-four hours. The toxin treatment also was resumed, the doses being increased every day up to the point of producing a temperature of 102° – 103° . The soft tumor-like area slowly increased in size and by April 1 it measured 1 by $\frac{3}{4}$ inch; it was non-fluctuating. On April 8, 150 mg. of radium emanations were applied to the lower and ulcerated portion of the swelling, and kept on for seven hours, after which it was moved two inches higher over the articular surface of the tibia. On July 22, 240 mg. of radium were applied over the same site, for fourteen hours. Her local condition continued to improve, the sinus gradually healed, and the patient's general condition returned to normal. The toxins were continued during the summer with occasional intervals of rest.

On October 4, 1916, when she left the hospital, there was no sign of a tumor and she was in good physical condition. By November 22, 1916, she had gained twenty-four pounds in weight.

This patient also was shown before the New York Surgical Society on November 22, 1916, and again in January, 1919, and was presented at the meeting of the American Surgical Association on June 16, 1919, at which time she was in good health with no evidence of local recurrence or metastases. She now walks with a brace without the aid of a crutch or cane. The recent X-ray pictures show almost complete restoration of bone. (Well October 25, 1919, over four years.)

CASE III.—Periosteal Sarcoma of the Tibia with Metastases in the Inguino-femoral Glands; Disappearance Under Toxin and Radium Treatment; Well at Present, Nearly Two Years. Mr. S., thirty-nine years of age, was referred to me on April 27, 1917, by Dr. John H. Gibbon, of Philadelphia. Family history negative.

Personal History.—The patient's general health had been very good, and he had practically never been ill. Ten years before he was struck by an automobile and suffered a compound fracture of the right leg, four inches above the ankle. There had been no injury to the left leg as far as known. Three weeks before he was referred to Doctor Coley the patient had noticed a swelling about two inches

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above the left ankle, extending upwards and involving the inner and anterior portion of the leg for a considerable distance. It was at first believed to be a periosteitis of inflammatory origin. In the latter part of April Doctor Gibbon was called in consultation and pronounced it a sarcoma. This opinion was strengthened by an X-ray examination.

Physical examination at the time of my first observation (April 27, 1917) showed a man in robust health. Examination of the left leg revealed a marked swelling occupying the lower third, apparently originating in the periosteum and extending nearly around the leg. It began about an inch above the internal malleolus and extended upwards five inches anteriorly, and $4\frac{1}{2}$ inches on the outer side of the fibula. There was marked oedema of the whole lower third of the leg extending to the ankle. The swelling, which was most prominent over the inner and anterior part, was soft, almost semi-fluctuating, and markedly tender on deep pressure; the skin was slightly discolored. $T. = 99.5^{\circ}$.

To definitely settle the diagnosis on April 27 an exploratory operation was made. A portion removed was examined microscopically by Doctor Ewing, who reported: "Section shows a tumor composed of small spindle cells consisting chiefly of nuclei. They are very numerous, with no visible stroma. The cell masses are very compact. The tumor is quite malignant in structure."

The patient was immediately put upon the mixed toxins of erysipelas and bacillus prodigiosus, which were continued four or five times a week in doses sufficient to produce a temperature of 102° – 104° .

MEASUREMENTS

April 30, 1917:

1 inch above the internal malleolus = $9\frac{5}{8}$ inches.

4 inches above the internal malleolus = $10\frac{5}{8}$ inches.

6 inches above the internal malleolus = $10\frac{3}{4}$ inches.

The tumor itself, anteriorly = $5\frac{1}{2} \times 5$ inches.

May 5, 1917:

4 inches above the internal malleolus = $10\frac{3}{8}$ inches.

6 inches above the internal malleolus = $10\frac{3}{8}$ inches.

The tumor itself = 4×3 inches.

May 11, 1917:

4 inches above the internal malleolus = $9\frac{3}{4}$ inches.

6 inches above the internal malleolus = $9\frac{3}{4}$ inches.

The tumor itself = 4×3 inches.

On May 1, 1917, the patient was treated with radium emanations 12 by 85 mc. (1020 mc.) through 2 mm. lead filter, 6 cm. distance, applied to the anterior surface of the leg for twelve hours.

On May 8, he received the following radium emanations: 660 mc., 2 mm. lead filter, 10 cm. distance, applied to the inner aspect of the leg for twelve hours, and on May 23 the same amount of radium emanations, 2 mm. lead filter, 6 cm. distance, applied to the external aspect of the leg for twelve hours.

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MEASUREMENTS

May 21, 1917:

Circumference of leg across centre of scar = $9\frac{1}{4}$ inches.

May 25, 1917:

Circumference of leg across centre of scar = $9\frac{1}{4}$ inches.

Circumference of leg across upper end of scar = $9\frac{9}{16}$ inches.

Circumference of leg across lower end of scar = $9\frac{9}{16}$ inches.

On May 26, 1917, the patient returned to his home, where the toxins were continued three times a week by Dr. R. G. Gamble, his family physician, and on June 19 he was again admitted to the Memorial Hospital for further radium treatment, at which time he received 1200 mc. emanations, through 2 mm. lead filter, 10 cm. distance, applied to the internal surface of the leg for eight and one-half hours. The toxins were then continued at home during June and July, but in view of the fact that all evidence of the disease had disappeared and he was in such fine general condition it was thought safe to discontinue the treatment for four weeks during the extreme heat in August and September.

The patient returned to Doctor Coley for observation on September 15, 1917, stating that he had recently discovered a swelling in the left groin, which was increasing in size. A physical examination showed the leg to be apparently normal. The left groin was occupied by several large glands involving the femoral, inguinal, and iliac regions, the largest of which was about the size of a big hickory nut. Doctor Coley removed one of these under general anaesthesia and forwarded it to Doctor Ewing for microscopical examination, who reported: "Actively growing sarcoma. Cells large polyhedral. No pigment. Nature of origin uncertain."

RADIUM TREATMENTS

(Oct. 1, 1917).—Radium emanation pack, 600 mc. for 7 hours, 2 mm. lead filter, applied at a distance of 10 cm. to the left inguinal and femoral regions.

(Oct. 2, 1917).—Radium pack, 480 mc., lead filter for 29 hours, at a distance of 10 cm. to the same region, making a total of 18,000 mc. hours.

(Nov. 8, 1917).—Radium pack, 1400 mc. (2 mm. lead, 0.5 mm. German silver), applied at a distance of 8 cm. over the left inguinal region for $6\frac{3}{4}$ hours.

(Nov. 9, 1917).—Radium pack, 1420 mc. (2 mm. lead, 0.5 mm. German silver), applied at a distance of 8-10 cm. over the left inguinal region for 6 hours.

(Dec. 7, 1917).—Radium pack, 1800 mc. for $6\frac{2}{3}$ hours (2 mm. lead, 0.5 German silver), applied over the left inguinal region at a distance of 8-9 cm.

The toxins have been continued for nearly two years with occasional intervals of rest. The doses have been comparatively small, not sufficient to interfere with his regular occupation, and his general health has remained perfect throughout the entire time. A recent physical and X-ray examination showed apparently no trouble remaining in the tibia and no evidence of metastases in any other part of the body.

This case, I believe, illustrates the advantage of combining the

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local effect of the radium with the systemic effect of the toxins; it also shows the importance of keeping up the toxin treatment in certain cases for a considerable period. It is too early yet to say that the patient is permanently cured, yet more than two years have elapsed since the disappearance of the primary tumor, and one and one-half years since the secondary. This patient was shown before the American Surgical Association June 16, 1919, at Atlantic City.

NOTE.—The patient was shown before the Clinical Congress of Surgeons of America in New York October 23, 1919, without trace of recurrence, in two and one-half years.

CASE IV.—*Central Sarcoma of the Femur with Extensive Involvement of the Knee-joint and Upper End of Tibia. Amputation advised, but refused; recovery under conservative treatment, curetting followed by systemic toxin injections and radium treatment; well at present, three years later.* C. S., female, twenty-nine year of age; married; family history good. Referred to me November 10, 1916; first noticed swelling over the inner condyle of the right femur seven months previously; the swelling was associated with a moderate amount of pain; admitted to St. Vincent's Hospital a few weeks before I saw her. An X-ray picture was taken and the diagnosis of sarcoma made; amputation strongly advised, but refused.

Physical examination November 10, 1916, shows a tumor occupying the whole lower end of the femur, most prominent over the anterior and inner portion, apparently involving the knee-joint. The tumor is soft and semi-fluctuating over most of the area, consistence varied in different portions. On the inner side the swelling extends down to and apparently involves the upper end of the tibia; it is smooth and globular in appearance; superficial veins dilated. Measurements of tumor— $6\frac{1}{2}$ inches on the inner side; 7 inches on the anterior side; $5\frac{1}{2}$ inches on the outer. Measurement over most prominent part of the tumor, $16\frac{1}{4}$ inches, 2 inches more than on the normal side. The popliteal space is partially filled up with a new growth of bone. The patient has been unable to walk for five months, and has lost 25 pounds in weight. Clinical diagnosis: Central sarcoma of the femur with extensive involvement of the knee-joint. X-ray examination shows a tumor occupying almost the entire lower end of the femur, apparently involving the knee-joint as well. There seems hardly any of the femur left, except the lower portion of the outer condyle. Amputation was strongly advised, but the patient absolutely refused. I finally decided to make an exploratory operation and to treat the patient with large systemic doses of the toxins of erysipelas and bacillus prodigiosus, possibly supplemented by radium. Operation, November 15: A tourniquet was applied at the upper and middle third of the right thigh and an incision 4 inches long made over the inner condyle along the inner border of the patella. A tumor, soft and semi-fluctuating, about the size of an orange, was found underneath the muscular layers. It had broken entirely through the periosteum, and while not actually infiltrating, had pushed to one side and outward the muscles and fascia.

By means of a curette and gauze sponges a large mass of soft grumous material of grayish-red color, macroscopically typical of sarcoma, was removed. The semilunar cartilages had been apparently entirely destroyed. The upper portion of the tibia for a distance of about 2 inches was almost completely destroyed and the whole joint was disorganized and occupied by a tumor which extended nearly through the outer condyle of the femur. The fibula was apparently not involved. Only a small shell of the outer side of the femur prevented spontaneous fracture. The tumor was finally curetted down to hard bone on the outer side and to the muscle and fascia overlying the popliteal vessels below, and to the upper end of the tibia until bare bone was reached. A cavity fully the size of an orange remained, which was packed tightly with gauze to prevent hemorrhage, and the limb put in a plaster splint. A pathological examination was made by Dr. James Ewing, who reported as follows: "The tumor has the general features of a giant-celled medullary sarcoma. Several areas are unusually cellular, which indicates a guarded prognosis." In a later report made on basis of examination of further sections, he states: "While the tumor shows certain areas of typical giant-cells, there are other areas in which the giant-cells are comparatively few in number and bunches of spindle- and round-cells are present."

This report taken in conjunction with the clinical history of the case, the very rapid growth of the tumor, perforation of the periosteum, complete destruction of the knee-joint and involvement of the upper end of the tibia, leave little doubt in my own mind that the tumor was a sarcoma of marked malignancy and could not be regarded as a giant-celled growth of benign character.

The packing was not completely removed until the end of a week, and the large cavity was kept clean by the use of Dakin's solution. Three days after the operation the patient was put upon systemic doses of the mixed toxins, the injections being made into the buttocks; the initial dose was $\frac{1}{2}$ m., and this was increased by $\frac{1}{2}$ m. daily up to the point of obtaining marked reactions. The highest dose was 14 minims. The patient was not very susceptible, and severe reactions did not occur until very large doses (10-12 m.) were reached. The large cavity gradually filled up with apparently normal granulation tissue. At the end of about two months the wound had practically closed without the slightest infection. Frequent X-ray pictures taken showed steadily increasing reproduction of bone at the site of the tumor.

The patient was shown before a conference at the Memorial Hospital on January 24, 1917, with the sinus healed, and able to get about on crutches. Just before the sinus had entirely closed, the toxin treatment was supplemented by the introduction of steel needles containing 100 mc. of radium, through the sinus at the bottom of the cavity; the needles were allowed to remain in place for three hours on three occasions. Later a radium pack treatment was given externally.

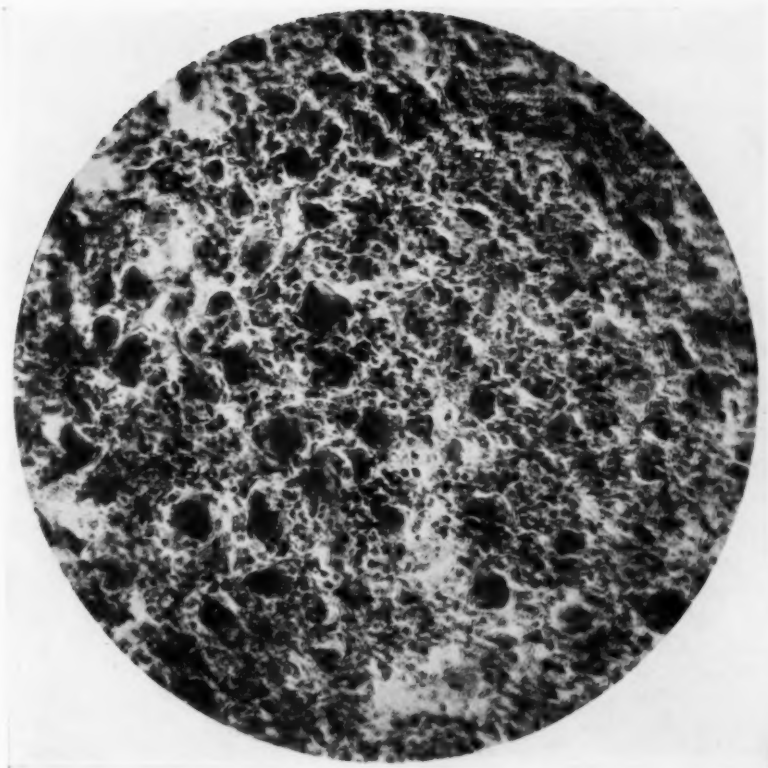


FIG. 1.—Giant-cell sarcoma of the femur, epulis type, recovering under simple curetting. Amputation advised and refused. Well in two years. Example of typical giant-celled tumor of low degree of malignancy.



FIG. 2.—Spindle-, round-, and giant-cell chondrosarcoma. Death from metastasis in lung three years after amputation.



FIG. 3.—(Case I.) Central sarcoma of femur before treatment, involving knee-joint and upper end of tibia. Treated by curetting, toxins and radium. Complete recovery—well and walking with scarcely any limp three years later.



FIG. 4.—(Case I.) Sarcoma of lower end of femur with extensive involvement of knee-joint. Amputation advised and refused. Recovered under systemic treatment with mixed toxins alone. Patient is walking without crutch or cane at present (four years and eight months). This photo, showing extensive growth of new bone, was taken four years and eight months after beginning of treatment. Patient still wears a brace.



FIG. 5.—(Case II.) Sarcoma of tibia three years and ten months after toxin and radium treatment, showing reformation of upper five inches of tibia without bone grafting and after complete destruction by sarcoma. Treated by toxins and curetting, August, 1915, after amputation had been strongly advised by other surgeons. Patient well, in four months. Then sarcoma recurred and grew rapidly. Second curetting. Rapid recurrence. Disappeared under toxins and radium. Well October 26, 1919, more than four years. This picture taken three years and ten months after treatment. For photographs and microphotographs taken before treatment see ANNALS OF SURGERY, March, 1917.



FIG. 6.—Same case as Fig. 5, three years and ten months after treatment.

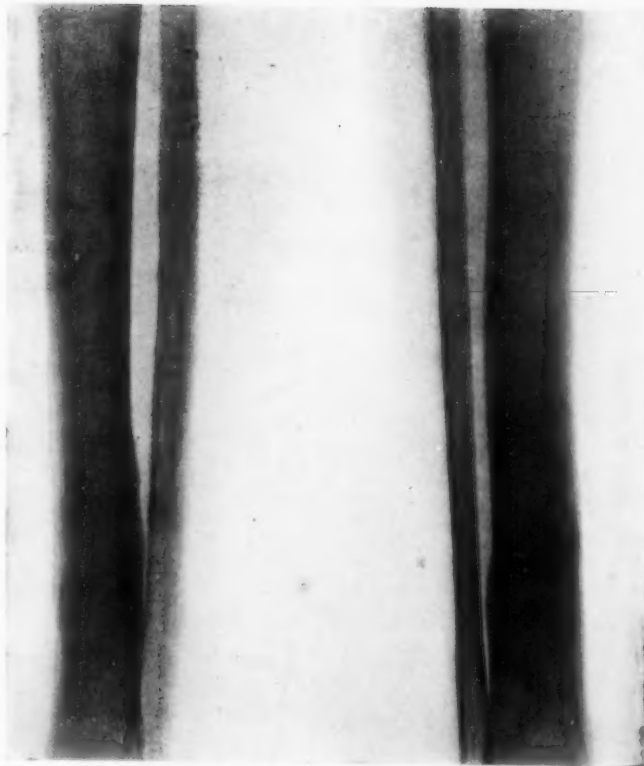


FIG. 7.—(Case III.) Periosteal sarcoma of tibia, spindle-celled.



FIG. 8.—(Case III.) Two years later spindle-celled periosteal sarcoma of tibia. Very rapid development.

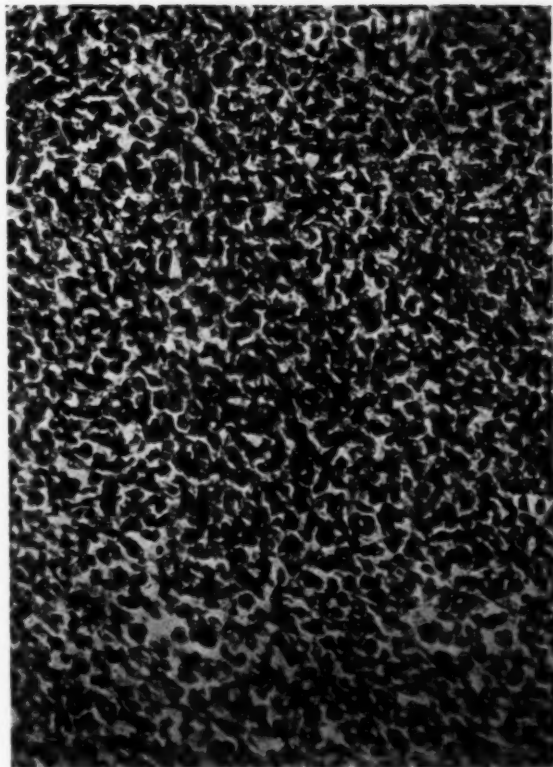


FIG. 9.—(Case III.) Periosteal sarcoma of the tibia. No giant-cells. Entire disappearance followed the use of toxins and radium, April, 1917. Recurred in glands of groin (femoral, inguinal and iliac) September, 1917. Diagnosis was confirmed by microscopic examination. Disappeared under further treatment but toxins were continued for two years. Patient well (January 16, 1919) without trace of disease. Microscopic examinations both made by Dr. Ewing. Diagnosis: Malignant spindle-celled sarcoma, no giant-cells.

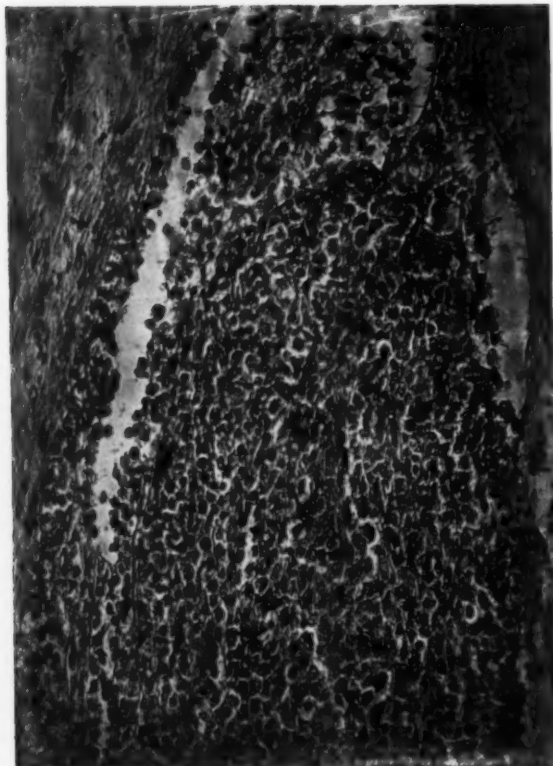


FIG. 10.—(Case III.) Section from metastatic tumor removed from inguinal region. Metastatic tumor six months later in groin, which disappeared under toxin and radium treatment. Again disappearance under same treatment and patient well and free from recurrence October 26, 1919, over two years from time treatment was begun.



FIG. 11.—(Case IV.) Central sarcoma of femur. Giant- and spindle-celled. Rapid growth, involving the knee-joint and upper end of tibia.

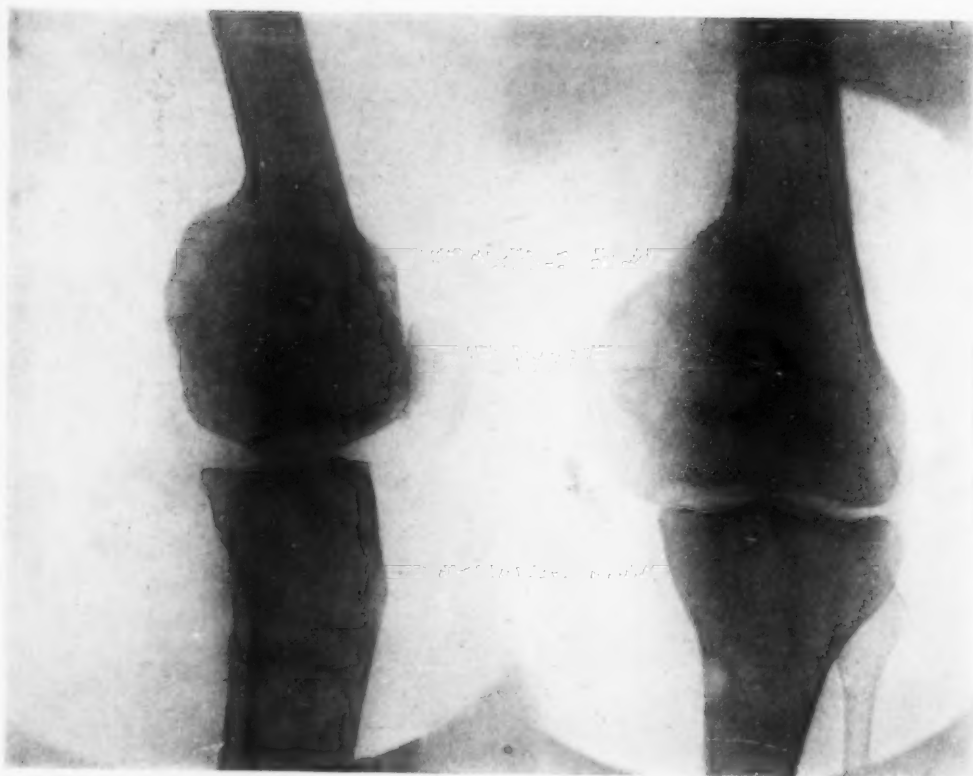


FIG. 12.—Same case as Fig. 11 two and one-half years later.



FIG. 13.—(Case V.) Spindle- and giant-celled sarcoma of femur involving knee-joint and upper end of tibia. Amputation advised by several surgeons and then at Vincent Hospital, but patient refused and was discharged. Amputation strongly urged by Dr. Coley and refused. Patient then treated by Dr. Coley by exploratory operation—curettage—followed at once by large doses of toxins. Cavity size of an orange healed by granulation. 100 mc. of radium inserted in sinus by means of steel needle and radium pack—used externally. Patient well October 26, 1919, nearly three years.



FIG. 14.—(Case V.) Inoperable periosteal sarcoma of femur. Disappearance under large doses of toxins and radium. Treated at Memorial Hospital, October, 1917, to July, 1918. Picture taken on admission. Entire disappearance of tumor and patient well October 26, 1919, two years.



FIG. 15.—(Case V.) Inoperable periosteal sarcoma of the femur. Disappearance under large [doses of toxins and radium. Treated at Memorial Hospital from October, 1917, to July, 1918. Picture taken one year after entering hospital, October, 1918.



FIG. 16.—(Case VI.) Sarcoma of femur. X-ray taken one year after beginning treatment with toxins and radium. Entire disappearance of very large sarcoma involving upper two-thirds of femur under eight months' treatment by massive doses of radium, and large doses of mixed toxins injected systematically into tumor. Patient well October 26, 1918, two years later, with five and one-half inches of shortening.



FIG. 17.—(Case VI.) Sarcoma of lower end of radius. Entire disappearance under toxin treatment alone in four months. Patient well at present, eighteen months later. See Fig. 19, taken seven months after treatment. Complete destruction lower three inches of radius. Rapid growth. Amputation advised by several surgeons.



FIG. 18.—(Case VI.) Seven months after treatment. Entire disappearance of tumor under toxin alone. Patient now well with useful arm, eighteen months after beginning of treatment.

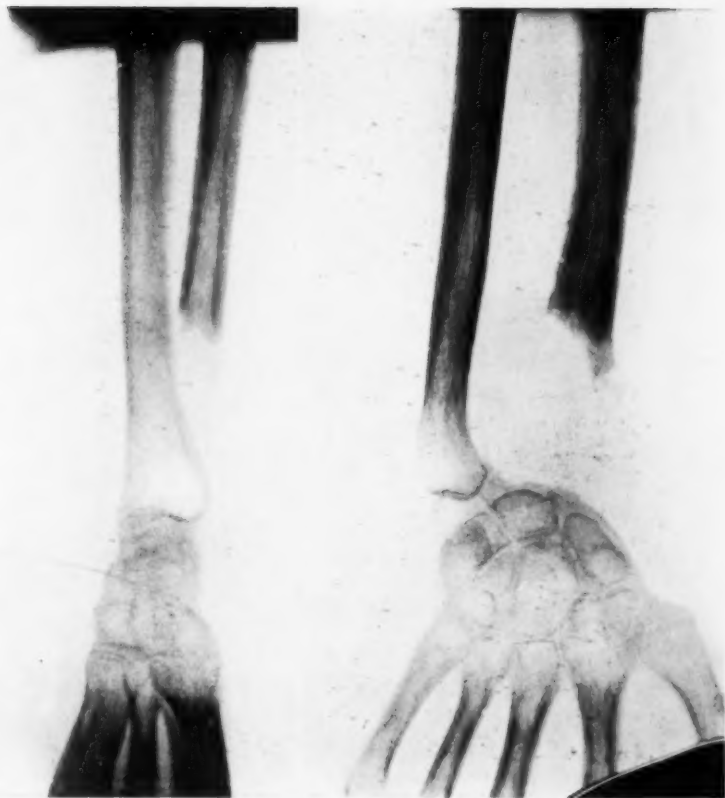


FIG. 19.—(Case VI.) Sarcoma of radius before treatment. Cured by toxins alone. Patient well October 25, 1919. Toxins injected into buttocks systematically one year and four months. No other treatment.



FIG. 20.—Same case as Fig. 19, seven months after treatment. Splint removed, and patient returned to work. Perfect function.

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The patient made an uninterrupted recovery. For the last two years she has been attending to her household duties without the use of crutch or cane. She was shown at a clinic given for the Clinical Congress of Surgeons of North America, October 23, 1919, three years after treatment, and walked with only a slight limp and was apparently in normal health. The X-ray picture shows that the original tumor area has been almost entirely replaced by new bone, and the limb is apparently as strong as it ever was. X-ray picture of the chest shows no evidence of metastases.

CASE V.—Very Large Inoperable Sarcoma of the Upper Portion of the Femur, Following a Recent Fracture; Disappearance Under Combined Toxins and Radium Treatment. Reunion of Pathological Fracture; Well at Present, Two Years After Beginning of Treatment. R. H., male, thirty-six years of age, had been entirely well up to January, 1917, when he slipped on the ice, causing a fracture of the left femur, a little below the trochanter. He was taken to St. Vincent's Hospital in Bridgeport, Conn., where he was treated by Dr. Geo. W. Hawley. X-ray pictures had been taken at the time, but owing to Doctor Hawley's having been engaged in military service, I have been unable to see the pictures as yet. The hospital report, however, mentions nothing more than an oblique fracture below the trochanter. If there had been a pathologic fracture due to a tumor already present, it probably would have been discovered at the time of the first X-ray picture. The patient did well for nine weeks, at the end of which time a swelling appeared at the site of the fracture, and steadily increased in size.

NOTE.—I have later been over the case personally with Colonel Hawley, and he states there was no evidence of tumor in the first X-ray pictures at the time of the fracture.

He remained at St. Vincent's Hospital for twenty-seven weeks. The tumor steadily increased in size, and on October 3 the patient was sent to the German Hospital, New York City, where he came under the care of Dr. Herman Fischer. On October 20 Doctor Fischer referred the patient as an inoperable sarcoma of femur to Doctor Coley's service at the Memorial Hospital. He was examined at the clinical conference of the hospital staff, and both Doctor Downes and Doctor Coley regarded the case as entirely beyond hip-joint amputation. At this time the middle and upper portion of the left thigh measured 68 cm., and the right thigh 51 cm., and there was a complete pathologic fracture at the upper and middle third of femur. Longitudinally the tumor extended for a distance of 17 cm. The mixed toxins were begun on October 30, and continued three or four times a week, alternating the systemic with local injections, and producing severe reactions. On November 5 and 6 he was treated with very large doses of radium, by means of a pack, applied at 10 cm. distance, and remaining for a total of sixty-one hours (total dose, 40,000 mc. hours). An X-ray picture taken at the time of his admission to the Memorial Hospital showed complete destruction of the bone, involving the neck of the trochanter and

upper five inches of the shaft. An X-ray picture of the chest showed "chronic diffuse bronchitis, both apices (cloudy plates) suggestive of tuberculosis—probably metastases from the tumor in the femur." By December 10 there had been a decrease of 4 cm. in the circumference of the thigh. The radium was again applied on December 25, 1917. Examination on April 8, 1918, showed a still further decrease in the circumference of the thigh. The toxins were kept up without further radium treatment. On June 23 the patient was sent home to Bridgeport, Connecticut, to remain there during the hot weather and return in the fall. At that time his general health was good; the tumor had decreased in circumference from 68 to 60 cm., with a corresponding decrease in the vertical dimension; there was still marked mobility at the site of the fracture. The leg was put in a Thomas splint. He received no treatment during the summer.

On October 8, 1918, the patient was readmitted to the hospital, at which time his general health was good, and clinical examination showed apparently complete disappearance of the tumor. The length of the left leg was 33 inches, and the right, $38\frac{1}{4}$ inches, showing a shortening of $5\frac{1}{4}$ inches. The circumference 5 inches below the trochanter, left side, was 21 inches, and the right, $23\frac{3}{4}$ inches. Circumference 5 inches above upper border of patella, left side, $19\frac{1}{2}$ inches; right, 20 inches. The patient had had no treatment since leaving the hospital in June. X-ray pictures taken at the time of his readmission showed apparently no tumor tissue left. The proximal portion of the femur at the site of the pathologic fracture had been drawn upwards to the region of the trochanter, and there was an attempt at union due to formation of new bone. X-ray examination of the chest was negative.

At the present time the patient is still wearing the Thomas splint adjusted by Doctor Gibney. This patient was kept under frequent observation during the fall and winter of 1918-1919, and was shown before the American Surgical Association June 6, 1918. He is still wearing a Thomas splint, but the pathologic fracture has united and is sufficiently firm to permit him to raise his leg without support. Recent X-ray photographs show no evidence of tumor and his general health is quite normal.

NOTE.—He was also shown at the Clinical Congress of Surgeons in New York October 23, 1919, two years after treatment.

CASE VI.—*Central Sarcoma of the Radius; Clinical and X-ray Diagnosis; Inoperable; Entire Disappearance Without Sacrifice of the Arm, Under Toxin Treatment Alone.* L. D. G., male, twenty-nine years, was referred to me by Dr. V. P. Gibney on April 25, 1918, with the following history:

Eight years ago had sprain of the wrist, but apparently completely recovered. In November, 1917, or five months prior to my first observation, he noticed sharp pain like the prick of a needle; two months later loss of power in hand; at the same time he noticed an enlargement of the lower portion of the left wrist, which enlargement increased rapidly. Physical examination showed enlargement of the

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lower portion of the left forearm, extending down to the wrist. The tumor was apparently primary in the radius, involving the lower three inches. The whole wrist was markedly enlarged, the circumference being $2\frac{1}{2}$ inches greater than on the normal side; there was apparently some thickening of the ulna as well. There was a pathologic fracture of the radius and almost complete fracture of the ulna as well. The skin was normal, not adherent; the tumor was soft, semi-fluctuating in consistency. The clinical diagnosis of sarcoma was made and confirmed by X-ray examination. The X-ray picture showed complete destruction of the radius over 2 inches; the tumor had apparently broken through the outer shell of bone and extended outward, involving the soft parts which were pushed to one side. On the left side the tumor extended beyond the ulna, which was apparently involved. The X-ray picture did not fully show the damage to the ulna, but the clinical examination showed almost complete pathologic fracture. Amputation had been advised and the patient was willing to sacrifice the arm, if necessary. He was admitted to the Hospital for Ruptured and Crippled on April 25, 1918, and put upon the systemic injections of the mixed toxins of erysipelas and bacillus prodigiosus. Only one injection was made directly into the tumor, $\frac{1}{8}$ minim. This was followed by a very severe reaction, a temperature of 104° , nausea and vomiting and marked herpes of the lip. The systemic injections did not produce any marked chill or severe reaction until the dose had been increased up to 6 m.

At the time the toxins were begun the measurement over the most protuberant part of the tumor, 2 inches above the lower end of the radius, was $10\frac{1}{2}$ inches; normal side, 8 inches. I at first intended to use both radium and the toxins in the hope of saving the limb. During the first two or three weeks of toxin treatment there was very little improvement, and in the early part of June, when I was out of town for a week, Dr. J. P. Hoguet came very near amputating the arm, believing that there was little or no hope of saving it by conservative treatment. The patient was quite willing to submit to the operation.

When on my return on the 10th of June there seemed to be appreciable improvement, we decided not to use any radium and the injections were kept up systemically, every other day, in doses sufficient to produce a temperature reaction of 102° to 104° . By the end of June the swelling had nearly disappeared, and by the end of July it had entirely disappeared. The arm had been kept in splints during the early part of the treatment and later, after the tumor had disappeared, was kept in plaster-of-Paris with the hand in an abducted position, to avoid deformity while the new bone was forming. The patient left the hospital and the treatment was kept up two or three times a week until the last of January, 1919. Frequent X-ray pictures were taken of the wrist, and these showed gradual increase in new bone taking the place of the 3 inches of radius and ulna which had been completely destroyed. The patient wore a short palmar

splint for six months; the new bone which has replaced the lower end of the radius is not entirely solid yet, but I believe it will soon be completely restored and the arm will be quite as useful as ever. I feel some confidence in this prognosis for the reason that in two similar cases in which the tumor had disappeared under the toxins without other treatment—both confirmed by microscopical examination—there has been complete restoration of the function of the respective limb; one of these patients is now well more than ten years.

NOTE (October 23, 1919).—The patient has been using his arm since January, 1919, and is doing his regular work as a grocer. He has normal functions and little deformity. This patient was shown before the Clinical Congress of Surgeons October 23, 1919.

The following case shows the difficulty sometimes experienced in determining in what cases to make use of conservative treatment and in what cases to amputate:

CASE VII.—*Sarcoma of the Radius and Ulna*. C. R., male, twenty-two years of age, was referred to me on September 22, 1914, with the following history: In May, 1913, he had first noticed a slight swelling in the lower end of the right radius; this was accompanied by pain which rapidly increased in severity. In September, 1913, the lower third of the radius was resected by Dr. Howard Lilienthal. The pathologic examination of the tumor showed it to be a round-celled sarcoma with no giant-cells. Four months later there was a return of the growth in the lower end of the ulna, with spontaneous fracture. Doctor Lilienthal then referred the patient to me for the toxin treatment. Physical examination at this time showed the lower half of the forearm enlarged, the skin purple in color; there was marked protuberance of the dorsal surface of the forearm extending down to the metacarpal bone. The swelling was soft, almost fluctuating, spontaneous fracture of the ulna, egg-shell-like crackling on palpation and some tenderness. The whole lower third of the ulna has apparently become disorganized and false motion is elicited almost at any point. There is marked silver-fork deformity of the wrist, and absence of the lower end of the radius. The X-ray taken on September 23, 1914, showed sarcoma of the radius with marked osteoporosis of post-operative remnant of radius; spontaneous fracture of ulna, marked sarcomatous involvement of ulna with some attempt at periosteal proliferation. Diagnosis: Osteosarcoma. The patient went out on a pass before treatment was instituted, and failed to return until October 13, 1914. During this short interval of three weeks the tumor had increased very markedly in size; it had attained the size of a small fist, involving the lower part of the right forearm and extending up a distance of two-fifths on the ulnar side and two-fifths on the radial. He remained in the hospital until October 31, 1914, and received nine doses of the mixed toxins, ranging from $\frac{1}{6}$ to $2\frac{1}{22}$ m., the highest temperature reached being 102.5° . The injections were made locally into the tumor. No marked change was noticeable from the treatment and the patient was

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referred back to Doctor Lilienthal for amputation, who operated upon him on November 2, doing a circular amputation of the humerus in its lower third. A little more than four weeks later, about the middle of December, the patient died of metastases of the lungs. A letter from Doctor Mandelbaum, who had again carefully gone over the sections in this case, states that there were found no giant-cells in either specimen. The X-ray picture in this case closely resembles the picture of the preceding case that recovered under toxins alone.

CASE VIII.—*Sarcoma of the Fibula of Marked Malignancy, Trauma.* H. D., male, twenty years, referred to me by Dr. E. J. Mitchell, of Memphis, Tennessee, on April 18, 1918. The patient had been perfectly well until ten weeks ago when, while wrestling at school, he sprained the right leg just below the knee. Two weeks later he began to have slight pain; a little later lameness developed, but no appreciable swelling, and frequent X-ray examinations showed nothing abnormal. About two weeks ago the patient was examined by Doctor Mitchell, who detected a slight swelling in the outer upper aspect of the right leg. An exploratory operation was performed by Doctor Mitchell on April 14, an incision $5\frac{1}{2}$ inches long being made over the fibula from the head downward, and a tumor was found involving the entire upper four inches of the fibula, extending into the knee-joint. The report of the microscopical examination made by Doctor Kraus, of Memphis, reads: "Endothelioma with some areas of rapid growth, round-celled type and others of slower development with central mucoid; the proliferation around pre-formed spaces is typical." The wound was drained and the patient referred to me for advice and treatment.

Physical examination at this time showed a 6-inch cicatrix beginning over the upper end of the fibula and extending to the upper and outer aspects of the knee; the exploratory wound was packed with gauze and there remained a good sized rubber drainage tube. There was very little swelling of the knee or leg and but slight tenderness over the knee, apparently little effusion of the joint. An X-ray picture taken showed extensive involvement of the upper portion of the right fibula, also evidence of involvement of the knee-joint. The patient has lost 20 pounds in weight and motion of the joint is extremely painful. The patient was put upon the mixed toxins of erysipelas and bacillus prodigiosus in doses to produce a slight chill. On the 21st of April the patient was given 6000 mc. hours of radium over the outer aspect of the tumor, and on April 25, a rubber tube containing 99 mc. of radium and four silver tubes were inserted into the sinus left from the exploratory operation covering the upper four inches of the fibula. It was left in place for six hours.

April 30: The tumor has steadily increased in size, in spite of the treatment; the effusion of the knee-joint is much more marked and there has been considerable swelling of the whole lower portion of the leg. At the site of the drainage tube in the upper portion of the wound there is beginning to appear a fungoid growth of tumor, bleeding very readily. The disease is progressing very

rapidly in spite of the treatment and immediate amputation is advised.

The toxins were given systemically for a considerable period after amputation; about four months later metastases developed in the chest. The disease ran a very rapid course, causing death six months from the time of amputation.

As regards the advantages and disadvantages of resection, I personally have never employed resection and bone-implantation in any of my cases. The end-results in the group of cases shown before the American Surgical Association—(a) extensive sarcoma of lower end of femur, well four years and eight months; (b) extensive sarcoma of upper end of tibia, well three years and ten months—show that Nature unaided is able to restore large defects in the long bones if the tumor tissue has been destroyed. Also in these cases recent X-ray pictures taken show in one case almost complete restoration of five inches of the upper end of the tibia, and in the other case a very successful attempt to reconstruct the lower end of the femur with formation of a new condyle in place of the one destroyed. If we can cure the disease and keep the limb at rest for a long period of time in plaster-of-Paris, very satisfactory results can be obtained without resection. In the cases that have come under my observation in which resection of the upper end of the humerus was performed by other men, the results have been so unsatisfactory that I hesitate to recommend this method of treatment. In one of these cases, rapid generalization of the diseases prevented an opportunity to judge of the end-results as regards the usefulness of the arm, and in the other, now six months after operation, the arm is entirely useless. I doubt if it will ever have any functional value even if the disease is cured, which at present is doubtful.

CASE IX.—*Sarcoma of the Humerus Treated by Resection.* E. D., male, twenty-eight years old, always well until September, 1917, when he received a series of vaccinations preparatory to entering the army. All the vaccinations were given in the muscles in the upper part of the right arm. A few weeks later, he began to have soreness at the site of inoculations and also loss of function of the arm. A swelling appeared and slowly increased in size until January, 1919, when he was operated upon by Doctor Hitzrot at the New York Hospital. A portion of the humerus was resected and grafts from the tibia implanted. On February 28, 1919, Doctor Hitzrot referred the patient to the Memorial Hospital for radium treatment. From that time up to the present, he has had a total of 75,000 mc. given at various occasions, varying from 9000 to 40,000 in a single application. The treatment has been given by Doctor Janeway. X-ray examination shows the absence of $3\frac{1}{2}$ inches of the right humerus. The pathological diagnosis made at the New York Hospital reads as follows: "Osteochondrosarcoma; diffuse, infiltrating growth, involving the entire bone, extending into the surrounding muscle and fascia; extensive infiltration of muscle tissue. Diagnosis: osteogenetic sarcoma."

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X-ray examination of the chest shows considerable infiltration about the right hilum, extending up into the apex; no definite glands.

July 1, 1919: The patient is still under treatment. A recent X-ray picture taken failed to show any evidence of a tumor either in the bone or soft parts, and chest examination is negative. It is too early to regard the disease as under control, but it is almost certain that the arm will be of little use, even if the patient is cured of the sarcoma.

The following case of periosteal sarcoma of the humerus is interesting from the fact that there are few recorded cases in which the patient has been well over three years. Of 54 cases of sarcoma personally observed, only 2 are known to be well beyond three years.

CASE X.—Mr. L., aged thirty-five years, was referred to me by Dr. J. M. T. Finney, of Baltimore, nine years ago. The tumor developed within two weeks after a spiral fracture of the humerus, and Doctor Finney believed that amputation offered no hope of saving the patient's life. In this case a large, rapidly growing tumor apparently disappeared under the toxin treatment alone; six months later it recurred and I performed a shoulder-joint amputation. This operation was followed by a very large recurrence in the pectoral muscle, which was only partially removed, and then prolonged toxin treatment given. The disease finally disappeared and the patient is now in good health, eight years later. A microscopical examination had been made by Doctor Bloodgood and also by Doctor Ewing; both pronounced it a highly malignant spindle- and round-celled sarcoma, no giant-cells.

This case has already been reported in full in the ANNALS OF SURGERY.

The following history illustrates the difficulties often associated with the early diagnosis of malignant tumors of the long bones. It plainly shows that in some cases it is practically impossible to make an early diagnosis, even with the aid of the X-ray and exploratory operation and microscopical section.

CASE XI.—*Spindle-celled Sarcoma of the Radius with Metastases.* W. T., aged twenty-six years, referred to me by Dr. David Felderbaum on March 26, 1919, with the following history: The patient, a college man, has always been very active in athletics; played much foot-ball, but does not remember any particular injury to the arm. Two years ago he first noticed what was believed to be rheumatic pain in the left arm, but there was absolutely no swelling. Three months later he had another severe attack of local pain, without swelling; physician could feel no tumor whatever. The first X-ray was taken in September, 1917, and showed the condition to be probably osteomyelitis. First operation in October, 1917, at the Mt. Sinai Hospital, by Dr. Alexis Moschcowitz. An incision was made and the bone scraped. The tissues removed were examined by Doctor Mandlebaum, who reported "no evidence of sarcoma." A month later the

pain returned and Doctor Moschcowitz, suspecting sarcoma, again operated. At this time pathological examination of the tissues removed showed sarcoma of the small spindle-celled type. In March, 1918, a third operation was performed by Doctor Moschcowitz, who resected the upper half of the radius. The pathological examination again showed small spindle-celled sarcoma. The patient remained perfectly well until November, 1918, one and one-half years later, when he began to feel pain in the right hip. A few weeks later a soft swelling developed over the occipital protuberance; this has been increasing in size steadily up to the present time (March, 1919). He also has had severe pains in the lower side of the right thorax, accompanied by some cough, but without loss of weight. The X-ray pictures revealed a large spherical mass replacing the entire root of the left lung and small numerous masses in the lower part of the right lung, apparently mainly pleural. There is a small amount of fluid in the right chest and numerous small nodules along the root of the lung. The picture of the skull shows a cystic condition eroding the occipital bone. The patient was referred to me for radium and toxin treatment. In view of the advanced condition of the disease and the marked generalization, it was decided to try the effect of intravenous injections of the active deposit of radium, together with a radium pack over the tumors of the skull. There was considerable decrease in the size of the tumor of the skull, and slight improvement in general condition. At the present time the pain is returning and the tumors are increasing in size and generalization of lesion progressing.

END RESULTS IN A SERIES OF 250 CASES OF SARCOMA OF THE LONG BONES
OBSERVED FROM 1890 TO 1919

The serious and almost hopeless prognosis of sarcoma of the long bones from a surgical standpoint was well brought out at a symposium on Sarcoma of the Long Bones before the Royal Society of Medicine in London, November, 1912. Of a series of 61 cases observed at St. Bartholomew's Hospital during the preceding ten years, all were treated by amputation, with the following results:

Of 25 cases of periosteal sarcoma of the femur not a single patient was alive over three years later; of the myeloid type, 4 in number, only 2 survived the three-year period. Of 8 humerus cases, not a single patient reached the three-year limit. Of 2 radius cases, 1 died and 1 remained well over three years. Of 11 periosteal sarcomas of the tibia, 1 remained well over three years, and of 3 myeloid type, 1 remained well over three years. Of 61 cases of sarcoma of the long bones only 5 were well over the three-year period.

The statistics of St. Thomas's Hospital, covering the same period, show 28 periosteal cases and 17 myeloid. Of the former, not a single patient remained well over three years; and of the latter, only 5 (all of the giant-celled type) remained well for that length of time.

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It is worthy of note that conservative treatment was not employed in any one of these cases, all having been treated by amputation.

Personal Cases.—An analysis of cases personally observed from 1890 to 1919 shows:

Femur	117
Humerus	54
Tibia	40
Fibula	8
Radius	12
Ulna	7
Clavicle	11
Metacarpal	2
Total	251

Of 117 femur cases, 21 were alive and well over three years. Of these amputation was performed in 15 cases, preceded or followed by a course of toxin treatment, and in no less than 6 cases the limb was saved by conservative treatment. Of these 6 cases, 3 were of the periosteal type and 3 central mixed, giant- and spindle-celled.

CASE I.—A small round-celled periosteal sarcoma involving two-thirds of the shaft of the femur, with extensive metastases in the ilium. Patient was treated with X-rays in February, 1902, for the tumor of the femur. Later a very large metastatic tumor developed in the ilium and was treated with toxins alone. The disease entirely disappeared, and he remained well for ten years, and then died of carcinoma, which developed in an old X-ray burn of the thigh.

CASE II.—Extensive periosteal sarcoma of the femur, clinical and X-ray diagnosis. Amputation advised by several surgeons, but refused. Treated with toxins alone. Well eight years.

CASE III.—Extensive periosteal sarcoma of the femur, small round-celled, no giant-cells; diagnosis confirmed by microscopical examination at the State Laboratory of North Dakota. Case pronounced beyond hip-joint amputation by Dr. Wm. J. Mayo. Toxins advised and carried out by Doctor Williamson, of North Dakota. Limb saved, patient in good health ten years later.

CASE IV.—Extensive central sarcoma of the upper portion of the femur, pronounced inoperable by Dr. A. P. Gerster. Diagnosis (giant-celled sarcoma) confirmed by microscopical examination. Pathologic fracture; curetting, followed by toxins; complete recovery, reunion of bone, useful limb. Patient well when last observed eight years later.

CASE V.—Central sarcoma of the femur, with extensive involvement of the knee-joint, believed to be too far advanced for conservative treatment and amputation recommended by Doctor Gibney and myself, but refused by patient. Entire disappearance of the disease under toxins alone, and patient well at present with a useful limb four years and nine months later.

CASE VI.—Sarcoma of lower end of femur, with extensive involvement of knee-joint and upper end of tibia. Amputation advised by several surgeons, including myself, as the condition was regarded too far advanced for conservative treatment. Complete recovery under curetting and long continued toxin treatment, supplemented at the end of two months by radium in the form of a pack, and 100 mc. of radium emanations introduced into the sinus in a steel needle. Patient well and walking about with scarcely any limp three years later.

Another case might be included, inasmuch as, while there was no microscopical

examination made, the clinical and X-ray findings pointed very strongly to a periosteal sarcoma of the femur. The tumor disappeared under the toxins alone and the patient was in good health ten years later; and still another case of periosteal round-celled sarcoma of the femur successfully treated with the toxins by Doctor Runyan, of Little Rock, Ark., under my direction. An exploratory operation was made in February, 1913; microscopical examination, small round-celled osteosarcoma; complete disappearance under four months' toxin treatment; patient in good health with a useful limb four years later.

Of 40 tibia cases, 8 were known to be well for a period of more than three years after operation. Of these cases amputation was performed in 4, and in 4 the limb was saved. The cases in which amputation was done are as follows:

CASE I.—Giant-celled sarcoma of tibia; amputation of the thigh; patient remained well for seven years and then died of lung metastases.

CASE II.—Central sarcoma of upper end of tibia; amputation alone; patient well ten years.

CASES III AND IV.—Both periosteal sarcoma, well over three years; amputation, followed by toxins as a prophylactic.

CASE V.—Periosteal sarcoma of tibia, well five years after amputation, died with metastasis of skull.

The 4 cases in which the limb was saved are as follows:

CASE I.—Periosteal spindle-celled sarcoma of tibia; entire disappearance under toxins; patient well at present, twenty years.

CASE II.—Central sarcoma of upper end of tibia; mixed-celled (round-, spindle- and giant-celled); disappearance under toxins; patient well eight years.

CASE III.—Mixed-celled sarcoma (spindle and giant cells) of upper end of tibia; twice recurrent; disappearance under toxins and radium; patient well three years later.

CASE IV.—Sarcoma of lower end of tibia. Giant-celled and spindle-celled. Three times recurrent. Disappeared under toxins and X-ray, 1905. Well at present, fourteen years.

Sarcoma of the humerus has long been regarded as the most malignant of all types of tumors of the long bones, and my own series of cases supports this view. Of 53 cases of sarcoma of the humerus, only 2 survived the three-year period, and both of these cases can reasonably be regarded as cures. In the other cases the patients have all died with the exception of 2, who are under treatment at present with only a moderate chance of getting control of the disease. In the 2 successful cases, 1 was a sarcoma of the upper end of the humerus, involving the portion of capsule; exploratory operation done by Dr. J. Bapst Blake. The disease was found to be quite inoperable, too far advanced for shoulder-joint amputation. The toxin treatment was carried out under my direction. The tumor entirely disappeared and the woman completely regained the use of her arm, and remained well for twelve years, when she died from some independent trouble. The diagnosis was round-celled sarcoma.

NOTE.—Doctor Bloodgood says he has never seen a giant-celled tumor of the humerus.

CASE II.—A very malignant periosteal, round- and spindle-celled sarcoma, no giant-cells, starting in the middle of the humerus, following a recent fracture. The tumor

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apparently disappeared under toxins alone; pathologic fracture reunited; recurrence in the head of the humerus six months later; amputation; large recurrent mass in the pectoral region; incomplete removal followed by toxins; final recovery; well eight years.

Of 12 cases of sarcoma of the radius, 4 remained well beyond the three-year period. They are as follows:

CASE I.—Large giant-celled tumor of the radius, treated by another surgeon by simple curetting; observed by myself; perfectly well eight years later.

CASE II.—Extensive sarcoma of the radius, involving the ulna; amputation, followed by toxin treatment; well ten years.

CASE III.—Giant-celled sarcoma of lower end of radius; curetting by Doctor Hartley; amputation advised but refused; complete recovery under toxins; patient well eleven years.

CASE IV.—Giant-celled sarcoma of lower end of radius; small portion removed for microscopical examination; no curetting; disappearance under toxins alone; well three years later.

CASE V.—Extensive sarcoma of lower end of radius, with involvement of the ulna. Clinical and X-ray findings permitted no doubt as to the correctness of the diagnosis; amputation advised by several surgeons but refused; complete disappearance under toxins alone in May, 1918. Patient well at present with a useful arm.

This may have been a giant-celled tumor, although the bony shell has been destroyed, and the tumor was of rapid growth.

Of the 6 ulna cases, one spindle-celled sarcoma in which amputation was done remained well for seven years and then died of abdominal metastases.

Of the 8 cases of sarcoma of the fibula, not a single patient is known to have remained well beyond the three-year period.

Of the 11 cases of sarcoma of the clavicle, a total excision was done in 3, followed by the use of the toxins. This group is as follows:

CASE I.—Sarcoma of clavicle; total excision three weeks after noticing a rapidly growing tumor, which followed immediately after an injury; toxins given; local and metastatic recurrences within three months; death shortly after; whole course of disease was less than five months.

CASE II.—Total excision of clavicle for a rapidly growing periosteal sarcoma (round-celled, no giant-celled), followed by a long period of toxin treatment; patient in good health at the present time, with perfect use of arm, nine years later.

CASE III.—Total excision of clavicle for a round-celled sarcoma, periosteal, which Dr. Maurice Richardson referred to me for toxin treatment as a prophylactic. Toxins given for six months; patient in good health nine years later.

These cases are of particular interest inasmuch as the high malignancy of sarcoma of the clavicle is well known, there being few cases of cure on record—except the Valentine Mott case, in which the diagnosis is now believed to be "chondroma" instead of "sarcoma."

A brief summary of the cases that have remained well over the three-year period:

Patients remaining well more than three years, 35. Of these the disease recurred and proved fatal after three years in 5 cases. One tibia, seven years; 1 ulna, seven years; 1 femur, five years; 1 tibia, five years; 1 femur, five years.

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TYPE OF TUMOR IN CASES WELL OVER THREE YEARS

<i>Periosteal</i>	
Femur	8
Clavicle	2
Radius	1
Ulna	1
Humerus	1
Tibia	1
Metatarsal	1
<hr/>	
Total	15

There were no giant-celled tumors in this series of cases. One case was pronounced a chondroma at the time of the first operation (hip-joint amputation performed by another surgeon); he remained well for five years, after which the disease recurred locally; I performed a second extensive operation, followed by a course of toxin treatment; the disease recurred again three years later, involving the pelvic bones; condition inoperable; failed to respond to large doses of radium; hopeless when last seen. This case proved to be a chondrosarcoma.

One patient with a spindle-celled sarcoma of the ulna remained well for seven years after amputation, and then developed an inoperable abdominal recurrence, causing death in less than a year. Another case, a periosteal ossifying sarcoma treated by amputation, later followed by toxins, remained well for about three years and then died of metastases.

In this series of cases the diagnosis was confirmed by microscopical examination, with the exception of one case, and in this, the rapid growth of the tumor in a young adult, combined with the very definite evidence of the X-ray picture, left little doubt as to the correctness of the diagnosis. The tumor disappeared under the toxins and the patient remained well for seven years.

In this group of periosteal tumors, amputation was performed in 9 cases, followed by toxins in 7. (For a more detailed history, see the preceding notes.)

<i>Central</i>	
Femur	7
Tibia	5
Radius	3
Humerus	1
<hr/>	
Total	16

Cases in which the Limb was Saved.—In this series of cases it has been found possible to save the limb in 17 cases; 11 by the use of the toxins alone; 4 by a combination of toxin- and radium-treatment; 2 by curetting (the latter 2 were giant-celled sarcomas, or giant-celled tumors). Of the 17 cases in which the limb was saved, 6 were of periosteal origin and 12 of central origin. Fourteen have remained well more than three years.

AN ANALYSIS OF THE RESULTS OF SIX YEARS' FOLLOW-UP SYSTEM IN A HOSPITAL SURGICAL SERVICE*

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THIS paper is a study of the end results obtained in the First Surgical Division of the New York Hospital from February 1, 1913, to January 1, 1919. This period covers 8456 patients, 7175 operations, 385 deaths. Sixty of these deaths were on non-operative cases. The cases have been followed according to the outline given in my paper, "A Surgical Follow-Up System," in the *ANNALS OF SURGERY* of September, 1916.

Briefly, the great bulk of cases, exception only being made for minor infections, etc., are examined three months after operation by the surgeon in whose charge the patient was or who performed the operation. Patients not reporting are written to. The excellent Social Service Department of the hospital has been able to trace numerous cases and give us some information about their condition. Cases of particular interest are followed for longer periods; for instance, the direct herniæ are followed for nine months, malignant tumors indefinitely. Patients are directed at the time they leave the hospital and also when they return for examination to come back to see the attending surgeon if at any time they develop symptoms or complaints. They are particularly encouraged to come on Mondays at three o'clock, which is our Field Round day, and the entire staff is present.

The condition of the patients is indicated as follows: *Excellent* means that the patient returns presenting absolutely no symptoms of any kind whatsoever and expresses himself in perfect health and perfectly satisfied with his surgical condition. *Satisfactory* means that there are no direct symptoms referable to his surgical condition, but that the patient may have some complaint, be that as it may, *e.g.*, constipation. *Unsatisfactory* means that the patient has not been improved or that there is a definite failure to obtain the desired results.

We have reason to believe that the tabulated results are made to appear bad by the fact that a large number of patients remaining in good health and having no complaints, do not respond to requests for information or examination. A very large proportion of these patients are recent and ignorant immigrants who exhibit little gratitude for benefits received, certainly not enough to give up half a day's work to report. *Per contra*, if anything is the matter with them, they are very anxious to confront the doctor with the fact.

* Read before the New York Surgical Society, November 12, 1919.

The work has been done for the most part by myself and the two associate surgeons, Dr. B. J. Lee and Dr. J. M. Hitzrot. In the first part of 1913 it was our privilege to have the coöperation of Dr. W. A. Downes who was then associate surgeon. Dr. C. E. Farr, assistant surgeon, also has taken part in some of the work and particularly during the period of the war.

Two periods of these six years have given unsatisfactory results. The system began in 1914; but for the sake of completeness, we went back and investigated, so far as we were able, our 1913¹ work, but were unable to trace a considerable portion of these cases. From July, 1917, to the end of this period war conditions materially handicapped us.

The responsibility of keeping track of these patients and sending for them has been entirely in the hands of Mrs. H. S. Harrison, and it is largely owing to her coöperation and the fact that this responsible part of the work has been done by one person that we have been able to get data of value.

Space will not allow of very detailed comments of these cases. Some of the more important groups will be the basis of papers to be published by the staff.

Whatever merit this publication may contain is believed to be due to the complete report of the entire service for six consecutive years, as studies of this kind are rare.

The First Surgical Division of the New York Hospital is under the control of Cornell Medical College and for eight months of the year there is very active teaching.

So far as feasible, some of the major groups of cases are assigned to particular members of the staff. For purposes of convenience, a certain uniformity of technic obtains; but the staff is not limited to any one method of treatment. This policy gives the individual operator opportunities to develop his own ideas and furnishes a comparison of different methods.

In the past year we have replaced disinfection of the skin by tincture of iodine by 5 per cent. picric acid alcohol solution and are much better satisfied with the results. The asepsis obtained is fully as good, probably better, and the occasional irritation such as is produced by iodine has become a thing of the past.

Two and a half years ago it was believed that better results would be obtained by discarding the newer methods of anæsthesia and in that period of time, with very rare exceptions, general anæsthesia has been obtained entirely by drop ether on the open cone. It is interesting to note that this method (suppressing preliminary nitrous oxide) does not result in any increased use of ether for the average anæsthesia. As time goes on we shall investigate whether the suppression of nitrous oxide has had any relation to the incidence of pulmonary embolism. It is my impres-

¹ The Division has been conducted by the Cornell Medical College since 1913.

FOLLOW-UP SYSTEM IN A HOSPITAL SERVICE

sion that pulmonary embolism became more marked about the time that complicated methods of anæsthesia, particularly those involving the use of nitrous oxide, were introduced.

Anæsthesia for five years has been in charge of Dr. W. L. Soule and this centralization in the hands of an expert has been attended with the very best results. We have had no case in which death could be attributed directly or indirectly to the anæsthetic.

I would make a plea for general anæsthesia, versus the routine use of local anæsthesia, which is employed by a good many surgeons, if given in a safe and controllable manner, namely, ether, open cone, by a responsible expert. While local anæsthesia undoubtedly has a very definite place in a certain group of cases, it is believed it has, on the whole, little or no effect in diminishing mortality.

A certain number of deaths from pulmonary embolism, infarct and thrombosis have been accepted by the surgical profession as seemingly inevitable. Many theories have been advanced to explain their occurrence, but none seems to furnish the true explanation. In all reports one thing stands out prominently; that is, that this condition follows operations below the diaphragm. In a previous paper² I have called attention also to the average age of the patients, namely, a large proportion occurring in middle or late life. My observations also rather combated the late development of these conditions. The cases here reported were also all below the diaphragm but showed an average age of about thirty-two years, an average development of symptoms five days after operation, death about five days later. (Exception is made of case which died sixty-seven days after operation.)

Our results may be considered from the standpoint of mortality and the restoration of function or return to health of patients. Results will fall into three main groups; namely *Good* (Group I), that is, as satisfactory as at present it is possible to expect; *Average* results (Group II), that is, no better or no worse than what we may commonly expect; and sufficiently *Bad* (Group III) to cause us disquiet and to seek for improvement of results.

Leaving aside the smaller groups for important subjects we have under Group I as follows:

GROUP I

MALFORMATIONS.³—These give good results, particularly in undescended testicle. The deaths were from extreme causes, such as spina bifida.

CIRCULATORY SYSTEM.—Forty-four operations for varicose veins⁴ with only two unsatisfactory results.

DIGESTIVE SYSTEM.—*Acute appendicitis*, 782 operations; 34 deaths (4.3 per cent.) can, I think, be classified as good in view of the class of cases admitted. A very large proportion are long delayed cases as our unfor-

³ Pulmonary Embolism Following Operation, Medical Record, January 9, 1909.

⁴ The Bellevue Nomenclature is employed in all tabulations.

⁵ This group will be the subject of a special paper.

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fortunate patients are of a class that does not seek early advice and does not always receive prompt attention, necessitating, necessarily, severer operations and greater risks. We are under the impression to-day that if anything, the delay in sending in cases is increasing. Only five cases of this group are noted as coming back with conditions marked unsatisfactory; in marked contrast with the large number of cases of chronic appendicitis presenting subsequent complaints.

SUMMARY OF DEATHS FROM ACUTE APPENDICITIS

Number of deaths	36
Males, 18, females, 18	
Number of operations	34

Ages

1-10 years	5
10-15 years	6
15-20 years	3
20-30 years	8
40-50 years	6
50-60 years	6
60-70 years	2

Time Elapsing Between Onset of Attack and Operation

1 day	3
2 days	12
3 days	3
4 days	3
5 days	5
6 days	2
8 days	1
2 weeks	2

One case too ill to give a history. Another ill four weeks. No definite history of acute attack.

All cases save one required drainage. All were complicated by peritonitis. Further complications were:

Pneumonia	2
Intestinal obstruction	4
Paralytic ileus	1
Pneumococcus infection	1
Suppurative pleurisy, necessitating second operation	2
Pulmonary infarct	3
Acute cholecystitis	1
Secondary exploration of subphrenic space for multiple abscess of liver	1
Acute cardiac dilatation	1
Nephritis	2

Tonsils, 559 operations with one death. This death was in no way connected with the operation, but the patient died eleven days after the opera-

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tion of meningitis. The operation performed was usually some form of radical enucleation and the functional results were exceedingly good.

Hemorrhoids, 184 operations, no deaths. Only 3 unsatisfactory results. This result was an agreeable surprise to us, for without this definite tabulation we would not have realized how uniformly successful this operation was.

HERNIAE.—*Femoral hernia*, 53 operations, 1 death. No recurrences. Unsatisfactory cases are those showing same pain as before operation, but no recurrence.

Femoral hernia, strangulated, 11 operations, 1 death, gave uniformly good after results.

Inguinal hernia. Of 849 operations, 168 were for bilateral hernia. Total number of operations, therefore, 933. Of the 65 cases of bilateral hernia operated on before 1916, 61 were operated on at one sitting, two at two sittings. From 1916 to 1919 of 103 bilateral herniæ, 96 were operated on at one sitting, 7 at two sittings. Of these 103 cases, 15 were direct, 68 indirect, 20 both direct and indirect. Since 1916 there have been 305 cases of hernia on the right side (including bilateral hernia). Of this number 142 have had their appendix removed.

There were two deaths; in one case from pulmonary embolism after a long illness. In this case the appendix had been removed with great difficulty. The second was an elderly man, a poor risk, who died from cardiac insufficiency and paralytic ileus. So far as mortality is concerned we believe our results are good, as owing to the greater demands for operation to-day the average age is much higher than it was some years ago. For some years we had made a practice of removing the appendix on the right side in a rather haphazard fashion, but to-day we make it a routine providing the conditions allow of a perfectly safe and easy removal, as we believe no risks should be taken of unduly traumatizing the intestine. It is interesting to note that three patients in whom the appendix was sought for and the search abandoned for the above reasons, subsequently returned to us for an operation for acute appendicitis. Possibly in cases where we cannot easily draw down the appendix and cæcum, there may be a chronic appendicitis which calls for operation. It has been interesting to note with what frequency the appendices removed as routine have shown pathological lesions, concretions, etc. In one case the appendix was full of pus.

As regards recurrences^{*} we have definite knowledge of only 20 but believe that it must be higher. We believe that the direct herniæ are more prone to recur and require special technic. We believe that we present here a higher percentage of operations for direct herniæ than is commonly reported, and attribute the fact to our methods of demonstrating the presence of direct hernial sacs which are often overlooked unless care is taken in searching for them. In fact, we have come to regard this careful extirpation of the entire direct

^{*} This group will be the subject of a special paper.

sac as the most important feature in obtaining a radical cure in addition to the special technic of replacing the deficient conjoined tendon, either by transplantation of the rectus, or, in addition, suturing the cut edge of the rectus sheath to Poupart's ligament.

INFECTIVE DISEASES.—*Tetanus*, 3 cases, all recovered. All treated by intraspinal injections of antitoxin in addition to other treatment.⁶

Tuberculosis of kidney, 15 operations without mortality. One subsequently died at home; in two the end results are not known. In the others the improvement in health and the disappearance of symptoms were for the most part very marked and gratifying.

REPRODUCTIVE ORGANS (FEMALE).—*Extra-uterine gestation*, 51 operations, 2 deaths. Many of these are ambulance cases, desperately ill. It is, therefore, fair to consider the mortality, 4 per cent., very good.

Chronic salpingitis, 211 operations, 5 deaths, represent in many cases very severe conditions, long neglected cases, and huge suppurating tubes. Our experience has taught us that so-called conservative measures, *i.e.*, saving a doubtful second tube or partial resection of a tube, are unsatisfactory; in fact, they generally leave the patient in a bad condition and more usually necessitate a second operation. Bilateral cases are best treated by a panhysterectomy, for, as a general rule, leaving a boggy incurably diseased uterus is poor surgery.

REPRODUCTIVE ORGANS (MALE).—*Hydrocele*, 62 operations; *varicocele*, 78 operations, gave surprisingly good results. The operation usually employed for varicocele was the high excision of veins; for hydrocele, radical excision, chiefly by von Bergmann's method.

TUMORS (BENIGN).—*Fibromyoma of uterus* gives a small mortality and very satisfactory after results.

Fibro-adenoma of breast. These operations, if done properly, with the Thomas special submammary incision, give excellent results, especially from the cosmetic standpoint. In only two of these patients are recurrences noted and probably from insufficient excision. I would like to call attention to the fact that in the twenty-five years of my hospital surgery I have performed a goodly number of operations for benign conditions of the breast which I believe have acted as a prophylaxis against carcinoma. I have never yet had one of these patients return to me with carcinoma of the breast or have I ever heard of such a condition developing in any of my patients.

URINARY ORGANS.—*Nephrolithiasis and calculus in ureter*, 52 cases, 30 operations, 2 deaths which were exaggerated conditions, requiring a nephrectomy in the presence of a marked pyonephrosis. It will be noted that operations for displaced kidney (nephroptosis) were very infrequent as we believe they should be.

Abscess of kidney and perinephritic abscess, 28 operations, 2 deaths. Results excellent, only two cases being reported unsatisfactory.

⁶ See article, "Comparative Value of the Methods of Treating Tetanus," in the American Journal of the Medical Sciences, December, 1916.

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DUCTLESS GLANDS AND SPLEEN.—*Diseases of the spleen*¹ (including *ecchinococcus cyst*), 12 cases, 10 operations, 1 death. The fatal case was one of splenomyelogenous leukæmia in which nothing further than an exploration was possible.

Of the splenectomies, 1 Banti's disease, 1 syphilitic enlargement, 1 von Jaksch's anæmia, 1 hæmolytic jaundice, 1 pernicious anæmia, and 1 *ecchinococcus cyst* have remained well, all with marked improvement.

One Banti's disease, 1 portal cirrhosis with splenomegaly (non-alcoholic), and 1 pernicious anæmia died after short improvement.

INJURIES.—*Fractures (including faulty union)*. During the period of these statistics 447 fractures were treated. There were 24 deaths (14 in the skull fractures). Two hundred and thirty-six cases reported for observation; of these 53 were excellent, 163 satisfactory, and 21 unsatisfactory. Forty-seven cases were not asked to return because the treatment received at the hospital could have no bearing on the result.

One hundred and sixty-eight operations² were done with 12 deaths; 10 in fractures of the skull, 2 in fractures of the femur (shock, 1; pulmonary embolism, 1).

The operative measures used with autogenous bone grafts, 30 cases (4 failures with subsequent operations in 2 cases); heterogeneous bone graft (beef bone) in 6 cases with 1 failure; Lane plate, 28 cases with 1 infection and 2 removals; Freeman external bone clamp, 2 cases; Quenu-Matthieu apparatus, 2 cases; suture of fragments, 33 cases; wiring, 2 cases; metal screw, 1 case; nail extension, 1 case; osteotomy, 9 cases; excision of fragments, 12 cases; arthroplasty for ankylosis following fracture, 6 cases; amputation, 8 cases. The remaining 30 operations were done to correct deformities which after correction needed no fixation or for coincident soft part injury (skull fractures).

GROUP II

DIGESTIVE SYSTEM.—*Cholelithiasis and cholecystitis*, 214 cases, 179 operations, 12 deaths. Many of these cases presented the terminal stages of severe infections and numerous cases of obstructive jaundice. It is not surprising, therefore, that the mortality should be a little high. The results, on the whole, were pretty fair, but we feel that we must exert considerable efforts to improve them. As regards cholecystotomy versus cholecystectomy, as time goes on the latter operation has been more frequently performed so that it is to-day the routine operation that we perform with improvement of results. A few cases have been encountered with carcinoma of the gall-bladder developing after a cholecystotomy some time before. A cholecystectomy done at the primary operation

¹"The Effect of Splenectomy on the Normal Individual and in Certain Pathological Conditions," by James Morley Hitzrot, *ANNALS OF SURGERY*, May, 1918.

²The large number of operations is due to the fact that a great many of these cases are those in which the original treatment outside the hospital has not been satisfactory and they have been sent to the hospital for correction.

would probably have eliminated the possibility of the carcinoma developing.

There has been no attempt to make use of the transverse incision for gall-bladder approach, as we have found in cases of common duct obstruction that the vertical incision, close to the middle line, is ample and usually gives very satisfactory exposure.

Pancreatitis. Of the 6 cases surviving operation all reported as in a satisfactory condition of health. The three deaths were very severe cases, two dying within a few hours after an exploratory operation.

DUCTLESS GLANDS AND SPLEEN.—*Exophthalmic goitre.* There were two deaths following ligation of a single artery under local anæsthesia. Both were severe cases which had grown steadily worse under prolonged medical treatment. The surviving cases showed, on the whole, fairly good results, certainly about as good as one can ever expect to get following operation.

HERNIE.—*Inguinal hernia, strangulated* (41 operations; 6 deaths). Of these six deaths, three cases required intestinal resection, two were complicated by pneumonia, and one case was a poor operative risk, a man seventy years of age. The ages of these cases were thirty-eight years, thirty-nine years, fifty-four years, sixty years, seventy years and seventy-two years. The two youngest patients died of pneumonia. This is a class of cases, especially in an elderly individual, where a two-stage operation has given in many cases good results. The first operation, done under local anæsthesia, is limited to overcoming the obstruction, usually very easy, or remedying the damage to the gut by an appropriate resection. The second stage for the repair of the hernia is done a few days later, usually under a general anæsthetic, when the patient has recovered from the shock and disturbance of his original condition.

Umbilical and ventral hernia. Both radical cure and operation for strangulation, 87 cases, 74 operations, 12 deaths. Seemingly this mortality is too high, but it must be remembered that a large proportion of these people are quite unsuitable for operation, many of them being stout elderly women with degeneration of the viscera and changes in the blood-vessels. Operation for radical cure was seldom done except in the face of a threatening condition or the patient's refusing to suffer the discomfort of a permanently irreducible hernia. In the strangulated conditions the operation is always prolonged and difficult and often requires intestinal resection.

INFECTIVE DISEASES.—*Tuberculosis of digestive system.* Peritoneum, 18 original cases, 3 deaths.

Report on 9 cases: 1 case died two weeks after leaving hospital.

Date of operation	Last report
June, 1918.....	May, 1919. Gained 13 pounds. No symptoms.
Apr. 9, 1917.....	May 22, 1917. Recurrence of condition. Sent to country.
June 5, 1918.....	Oct. 10, 1918. Feels much better. Gained 3 to 5 pounds. Still has abdominal sinus and free discharge.

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Date of operation	Last report
July 19, 1917.....	Nov. 4, 1918. Fat and well. Complains of pain in right lower quadrant and vague symptoms.
Nov. 22, 1914.....	Mar. 15, 1915. Working and well.
Aug. 6, 1915.....	Nov. 29, 1915. Patient has gone to Germany. In good health.
Aug. 25, 1915.....	Feb. 13, 1919. Marked improvement. Abdomen soft, no fluid. No masses felt. Gained in weight.
Oct., 1915. No operation..	Jan., 1916. Looks very bad.

Cases found under those returning for second operation: Five cases—1 death in hospital; 1 case 21 days after leaving hospital; 1 case not found. Report of other two: Operation, September 24, 1917. Note, December 31, 1917. General condition markedly improved. Still has an open granulating wound, discharging some pus. Operation for tuberculous kidney October 4, 1915. Operation for tuberculosis of peritoneum January, 1917. January 5, 1919: Absolutely all right.

REPRODUCTIVE ORGANS.—*Acute salpingitis.* On the whole, we do not favor operations in the acute stages as convalescence is rather more stormy and the risk somewhat greater. Operation has more often been resorted to when the patients failed, under observation, to show speedy signs of improvement. A certain number of cases have wisely been operated on at this stage owing to the real difficulty sometimes encountered in differentiating between acute right salpingitis and appendicitis, and we prefer to take no chances where such a doubt exists.

Prolapse, retroflexion, retroversion, lacerated cervix and relaxed pelvic floor. While the results on the whole are satisfactory, we are seeking constantly to improve our methods, especially in the very extreme cases of prolapse of the third degree. It is not our custom to operate on retroversion, simply on the anatomical finding, but to relieve definite symptoms. The repair of laceration of the cervix gave good results.

GROUP III

DIGESTIVE SYSTEM.—*Ulcer of stomach and duodenum.* The results in this class of cases were unsatisfactory as regards operative mortality, 8.5 per cent., which is rather high, although the more recent work has shown marked improvement in that direction. They are, of course, unselected cases and many of them present advanced conditions, making operative procedures complicated and difficult. As regards functional results, on the whole, they are fair. The best results have been obtained in the well-defined, duodenal ulcers, treated by gastro-enterostomy without any other operative procedure. A few cases had some form of blocking of the pylorus added to the gastro-enterostomy. On the whole, these cases did not do so well and this procedure has been abandoned by me. More recently we have had the benefits of better and more accurate ante-operative observation and diagnosis, such as fluoroscopic examination (by Dr. A. L. Holland) with resulting benefits to our results in every way.

Ulcer of stomach and duodenum, perforating. The results are two-fold: the operative mortality is too high (10 deaths out of 39 operations),

but the after-results have been very good, no case being recorded as unsatisfactory and the great bulk of patients have shown marked improvement in health. Gastro-enterostomy at the time of the original operation has only very exceptionally been performed. None of the cases here recorded has undergone it subsequently. The mortality of the perforating ulcer of the stomach is almost entirely a question of time, and the following table simply serves to demonstrate this fact. It will be noted that only one case which was operated on less than twenty-four hours after the perforation occurred died.

TIME ELAPSING BETWEEN PERFORATION AND OPERATION
(Report on 39 cases of perforating ulcer of stomach and duodenum)

1. Deaths	10
Forty-eight hours (2)	
Forty-six hours	
Thirty-six hours	
Twenty-four hours (3)	
Twelve hours	
One patient ill ten days.	
One too ill to give detailed history. Had apparently been ill two weeks.	
2. Still living	29
One and three-quarter hours	
Between 2 and 3 hours (2)	
Between 3 and 4 hours (5)	
Four hours (2)	
Five hours (6)	
Seven hours	
Eight hours (3)	
Nine and three-quarter hours	
Seventeen hours	
Twenty-four hours (4)	
Three days	
Five days	
Ten days. Patient operated on five days after admission for abdominal abscess; five days later for perforating ulcer. His illness had been of two weeks' duration. Operation for ulcer ten days after admission.	

Cirrhosis of liver, 5 operations, 3 deaths. In general our impression has been that the results from omentopexy for cirrhosis of the liver are usually bad. Most of the cases are exceedingly poor operative risks with marked renal disease who react very unfavorably to operative procedures. We believe that only a very favorable case should be considered for operation.

Chronic appendicitis,^{*} 552 operations with 3 deaths. As the number of unsatisfactory cases is quite large a very exhaustive investigation of the subject will be published by me soon. The number of unsatisfactory cases, 30 per cent., is somewhat exaggerated, as we have definite reasons for believing that in the 139 non-investigated cases we probably had the best results. We may say in general that the results were best in the

^{*} This group will be the subject of a special paper.

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male, in patients with definite history of previous attacks, in cases presenting well marked pain over the site of the appendix as the principal symptoms. Also in patients whose general intelligence and knowledge of the English language allowed them to give satisfactory histories. In the thoroughly satisfactory cases the appendix is definitely noted as obviously pathological in 86 per cent., while the proportion diminishes as the results become unsatisfactory. Of recent years all operations have been conducted as exploratory laparotomies; that is, the small "interval" incisions have been abandoned. Of our 246 excellent cases only 6 were readmitted, while the 100 unsatisfactory yielded 26 readmissions.

INFECTIVE DISEASES.—*Typhoid fever with perforation.* All cases died, although it is fair to believe that in at least two cases the patients died of the typhoid fever and not of the sequelæ of the perforation or operation. The operation is, for the most part, done under local anæsthesia with the help of generous doses of morphine. Typhoid fever is not coming to operation any earlier nowadays because much time is lost in making blood examinations, which in the presence of the customary leucopænia are a waste of time.

Lymphadenitis, tuberculous. This is one of the most unsatisfactory problems. The class of cases chosen is usually those in whom operation could not be avoided; that is, with established or threatened suppuration. Twenty-two of these patients required subsequent operations for the removal of recurrent nodes, and it will be noted that no case was described as excellent. It must, however, be admitted that the classification is a little too severe, as a failure to record a case as excellent is often based on the presence of palpable lymph-nodes in the neck, which are practically always present in the neighborhood of the operative field. So far as feasible other remedial measures were effected—removal of diseased tonsils, care of the teeth, and sojourn in the country—but, of course, in only a limited number.

REPRODUCTIVE ORGANS (MALE).—*Hypertrophy of prostate.* The mortality is higher in these ward cases (4 deaths after removal of the prostate, 1 death after drainage under local anæsthesia) and does not represent the true status of prostatic surgery. Here again we have the neglected terminal stages in which we are forced to resort to some form of intervention. Our experience in private work, with well selected cases, is much more satisfactory. The removal in all cases was by the suprapubic method to which we are now committed. However, the results of these operations were, on the whole, quite good.

TUMORS (MALIGNANT).—This is the saddest part of our study. The tables speak for themselves and require little comment. However, fortunately, this study does not quite fairly represent the cancer situation, as this entire paper is based on the admissions to the wards, who are chiefly neglected, hopeless cases. Results in private work are better, but not sufficiently so to make us optimistic. Moreover, the cancer situation

has been complicated by the introduction of various therapeutic measures, some holding out some legitimate hope for their usefulness, others of the fake or "catch penny" sort. These result in confusion to the profession and deception to the public, and the pitiful cancer sufferer is made the victim, as he does not get a square deal.

An attempt has been made to analyze the opinions that cancer patients receive prior to their admission to the hospital. These have been collected by Doctor Farr in a paper entitled "Delay in the Treatment of Cancer."¹⁰

It will be noted that none of these cases is recorded as excellent. We do not feel that we can so classify them, owing to the possibility of a recurrence. We have, therefore, divided them into two groups—satisfactory (free from recurrence) and unsatisfactory (recurrence).

Carcinoma of the breast. In general our follow-up report of breast carcinoma shows that recurrence is much more frequent than one would believe from the literature. We believe that a patient should be in good condition six years after operation to count a case as cured. As our series only goes back six years we believe that not enough time has elapsed for us to draw definite conclusions. In our study of breast cases, we believe that cases come too late for operation and that progress must be made towards earlier recognition and earlier operation.

SUMMARY OF CARCINOMA CASES

(Including carcinoma, adenocarcinoma and epithelioma)

Number of cases	259
Number of known deaths	169
Number of cases living	41
(Ten of these unsatisfactory)	
Unknown	49
Number of operative cases	202
A. Number of deaths	130
In hospital	47
At home	83
B. Satisfactory results	29
C. Unsatisfactory results	8
D. Unknown	35
Of this number 20 were followed in part	
(12 satisfactory, 8 unsatisfactory)	
E. No specimen removed	15
Number of cases not operated upon	57
A. Number of deaths	39
In hospital	5
At home	34
B. Satisfactory (dubious diagnosis)	2
C. Unsatisfactory	2
D. Unknown	14
Of this number 2 cases were followed in part,	
both being unsatisfactory.	
Total number of cases	259

¹⁰ American Journal of the Medical Sciences, January, 1919.

FOLLOW-UP SYSTEM IN A HOSPITAL SERVICE

REPORT OF CARCINOMA CASES THAT ARE STILL LIVING

Diagnosis	Date of operation	Date of last report	Resulting condition
Breast	Nov., 1913	Dec., 1918	Satisfactory
Breast	Mar., 1914	July, 1918	Satisfactory
Breast	Aug., 1914	Sept., 1918	Unsatisfactory (recurrence)
Stomach*	Mar., 1914	Mar., 1919	Satisfactory
Stomach	July, 1914	Jan., 1919	Satisfactory
	Operation refused		
Face	Jan., 1914	Jan., 1919	Satisfactory
Lip	May, 1914	Apr., 1919	Satisfactory
Tongue	Sept., 1914	Feb., 1919	Satisfactory
Appendix	Feb., 1915	Mar., 1919	Satisfactory
Breast	July, 1915	Apr., 1919	Satisfactory
Breast	Mar., 1915	Mar., 1919	Satisfactory
Stomach*	Nov., 1915	Feb., 1919	Satisfactory
Face	Nov., 1915	Jan., 1919	Satisfactory
Breast	Jan., 1916	Dec., 1918	Satisfactory
Breast	Mar., 1916	Jan., 1919	Satisfactory
Breast	Aug., 1916	Feb., 1919	Satisfactory
Stomach*	Nov., 1916	Sept., 1918	Satisfactory
Uterus	Jan., 1916	Feb., 1919	Unsatisfactory (recurrence)
Uterus	Apr., 1916	Apr., 1919	Unsatisfactory (recurrence)
Lip	Mar., 1916	Apr., 1919	Satisfactory
Breast	Feb., 1917	Feb., 1919	Unsatisfactory (recurrence)
Breast	Apr., 1917	Jan., 1919	Satisfactory
Breast	June, 1917	Mar., 1919	Unsatisfactory (recurrence)
Breast	Feb., 1917	Feb., 1919	Satisfactory
Breast	June, 1917	Mar., 1919	Unsatisfactory (recurrence)
Lymph nodes	June, 1917	Oct., 1919	Satisfactory
Rectum	June, 1917	Mar., 1919	Satisfactory
Intestines	Oct., 1917	Apr., 1919	Satisfactory
	Operation refused		
Uterus	Aug., 1917	May, 1919	Satisfactory
Bladder	Oct., 1918	Mar., 1919	Satisfactory
Bladder	Mar., 1918	Apr., 1919	Satisfactory
Breast	Oct., 1918	Mar., 1919	Satisfactory
Breast	Aug., 1918	Apr., 1919	Unsatisfactory (recurrence)
Breast	May, 1918	Mar., 1919	Satisfactory
Larynx	Feb., 1918	Apr., 1919	Satisfactory
Lymph nodes	Aug., 1918	Jan., 1919	Satisfactory
Intestines	Oct., 1918	Feb., 1919	Unsatisfactory (recurrence)
	Operation refused		
Uterus	Dec., 1918	Apr., 1919	Unsatisfactory (recurrence)
Uterus	Mar., 1918	Feb., 1919	Satisfactory
Uterus	Mar., 1918	Nov., 1918	Satisfactory
Lip	Feb., 1918	Apr., 1919	Unsatisfactory (recurrence)

* Diagnosis probably wrong—no specimen.

CHARLES L. GIBSON

REPORT ON "UNKNOWN RESULTS"

Number of unknown cases	49
(Of this number 14 had no operation.)	
Cases having no note	27
Cases followed in part	22

Diagnosis	Date of operation	Last note
Breast	Sept., 1913	June, 1914: Satisfactory
Breast	Mar., 1913	No note
	(No operation)	
Intestines	Nov., 1913	July, 1916: Satisfactory
Maxilla	Apr., 1913	No note
Fallopian tubes	June, 1913	No note
Stomach	Feb., 1913	No note
	(No operation)	
Uterus	July, 1913	No note
	(No operation)	
Omentum	Mar., 1913	No note
Breast	June, 1914	Mar., 1917: Satisfactory
Breast	May, 1914	No note
Intestines	May, 1914	Oct., 1914: Losing strength rapidly. In bed all the time
Intestines	Apr., 1914	Aug., 1914: Slightly improved
Lymph nodes	Nov., 1914	Dec., 1915: Slightly improved
Uterus	Aug., 1914	No note
	(No operation)	
Uterus	Aug., 1914	No note
Ovary	Feb., 1914	No note
Lip	Dec., 1914	No note
Lip	Feb., 1914	No note
Lip	Jan., 1914	July, 1916: Satisfactory
Penis	Jan., 1914	Jan., 1915: Satisfactory
Breast	Oct., 1915	Feb., 1916: Satisfactory
Bladder	Aug., 1915	Dec., 1915: Unimproved
Intestines	Sept., 1915	No note
Prostate	Apr., 1915	No note
Stomach	May, 1915	No note
Stomach	May, 1915	June, 1915: Feels better; has returned to work
Stomach	May, 1915	No note
Uterus	Oct., 1915	Jan., 1916: Living on coal barge
Lip	Aug., 1915	Feb., 1916: Satisfactory
Breast	Aug., 1916	Apr., 1918: Losing ground rapidly
	(No operation)	
Esophagus	July, 1916	July, 1917: Unimproved
Rectum	Nov., 1916	No note
	(No operation)	
Stomach	Dec., 1916	Jan., 1917: Return of symptoms
Face	Jan., 1916	Dec., 1916: Satisfactory
Vulva	June, 1916	Nov., 1916: Marked recurrence
Breast	June, 1917	Nov., 1917: Satisfactory.
Breast	June, 1917	Apr., 1918: Extensive recurrence

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REPORT ON "UNKNOWN RESULTS"—*Continued*

Diagnosis	Date of operation	Last note
Intestines	Mar., 1917	No note
Intestines	Aug., 1917	No note
	(No operation)	No note
Prostate	Dec., 1917	
	(No operation)	No note
Rectum	Jan., 1917	
	(No operation)	No note
Breast	Mar., 1918	
Intestines	Aug., 1918	No note
	(No operation)	
Intestines	July, 1918	No note
	(No operation)	
Prostate	Oct., 1918	No note
	(No operation)	
Stomach	Mar., 1918	
Thyroid	Aug., 1918	
	(No operation)	Nov., 1918: Satisfactory
Ovary	Aug., 1918	
Tongue	Mar., 1918	
	(No operation)	Nov., 1918: Very ill

The educational value of the information obtained by a study of end results has been particularly impressed on the whole staff as time goes on. It was not long before several surprising factors became apparent, and we were able to substitute definite data for vague impressions. In several instances it came as a shock that we were getting poor or bad results of which we were in blissful ignorance, and were stimulated to improve our work with beneficial results. We have a weekly conference of the whole staff which includes a report of the follow-up work of the previous week and, in addition, quarterly and annual reports so that all members of the staff are constantly in touch with the situation.

In view of our enforced revision of judgment concerning our end results obtained by the follow-up system, we feel a certain reluctance to accept statements on such matters unless there is evidence that a systematic effort is made to check up such results.

The accompanying tables give the details of the results obtained:

REPORT OF FOLLOW-UP WORK FROM FEBRUARY, 1913, TO DECEMBER, 1918, INCLUSIVE

Diagnosis	No. of cases	No. of deaths	No. of operations	Readmitted	2nd operation	To return	Re-reported	Excellent	Satisfactory	Unsatisfactory	Died at home
<i>Congenital Abnormalities and Malformations:</i>											
Malformations.....	87	5(1)*	73	Tonsils..... Neurasthenia..... Hare lip.....	1 0 Died	57	45	24	17	4	
<i>The Blood:</i>											
Streptococcus blood infection.....	1	0	0	.....	0						
<i>Bones and Cartilages:</i>											
Abscess of bone.....	2	0	2	.....	.....	2	0				
Faulty union.....	22	0	22	Faulty union (4 cases) Fractured femur.....	..... Died	19	17	2	13	2	
Necrosis.....	3	0	3	Abscess.....	1	2	2	...	2		
Osteomyelitis.....	104	9	93	Osteomyelitis (11 cases)	8	69	50	10	29	9	2
Ostitis deformans.....	1	0	1	.....	.....	1	1	...	1		
Periostitis.....	5	0	2	.....	.....	3	2	...	1	...	1
<i>Bursae:</i>											
Bursitis.....	26	0	20	Bursitis..... Ulcer-leg.....	1 1	19	14	8	5	1	
<i>The Circulatory System:</i>											
Aneurysm.....	8	1	8	Aneurism.....	1	6	3	...	2	1	
Arteriosclerosis.....	1	0	1	.....	.....	1	1	...	1		
Cardiac valvular disease.....	2	0	0	.....	.....	0		...			
Endarteritis obliterans.....	8	0	5	Endarteritis.....	3	8	6	1	3	1	1
Myocarditis.....	1	0	0	.....	.....	0					
Thrombosis.....	1	1	1	.....	.....				
Varicose veins.....	49	0	44	Varicose veins.....	1	42	32	12	18	2	
<i>Digestive System:</i>											
Appendicitis, acute.....	789	36(2)	782	Fecal fistula..... Ventral hernia (11 cases) Salpingitis..... Tonsils (3 cases) Abdominal sinus Cystitis (1) P. O. adhesions (2) Cholelithiasis..... Constipation.....	3 10 3 2 1 0 0 0 0	623	502	313	182	2	

1

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REPORT OF FOLLOW-UP WORK FROM FEBRUARY, 1913, TO DECEMBER, 1918, INCLUSIVE.—Continued

Diagnosis	No. of cases	No. of deaths	No. of operations	Readmitted	2nd operation	To return	Re-reported	Excellent	Satisfactory	Unsatisfactory	Died at home
<i>Digestive System:</i>											
<i>Visceroprostis.</i>											
Ulcer of cecum.....	14	0	2	.....	...	2	2	...	2		
Stricture of intestine.....	1	0	1	.....	...	1	1	1			
Abscess of liver.....	6	0	6	.....	...	4	3	2	...	1	3
Cirrhosis of liver.....	7	3	5	.....	...	4	4	...	1	...	2
Cholelithiasis and cholecystitis....	214	14(2)	179	.....	Died	166	142	48	80	12	
Abscess-liver.....				.....	...	1					
Abscess of muscle.....				.....	...	1					
Stenosis of gall bladder.....				.....	Died						
P. O. adhesions.....				.....	4						
Constipation.....				.....	0						
Ventral hernia.....				.....	2						
Carcinoma of gall bladder.....				.....	Died						
Fibromyoma of uterus.....				.....	1						
Tubercular vertebra.....				.....	0						
Cholelithiasis.....				.....	Died						
Strangulated inguinal hernia.....				.....	1						
Ventral hernia.....		2(1)	4	.....	...	3	2	...	1	1	
Circumcision.....		1	25	.....	1	24	23	3	13	7	
Pulmonary tuberculosis.....		10(2)	16	.....	...	7	5	2	2	1	1
Tubercular hip.....		1	559	.....	1	281	227	173	53	...	
Axillary abscess.....				.....	1						
Abscess-rectum.....				.....	...	2	1	1	...	...
Structure urethra.....				.....	...	1	1	...	1		
Fistula in ano.....				.....	...	2	2	...	2		
Inguinal hernia.....				.....	...	2	2	...	2		
Hemorrhoids.....				.....	...	6	6	4	2		
Lacerated tendons.....				.....	...				
Stricture of rectum.....				.....	1	61	46	14	26	6	
Abscess about rectum and fistula in ano.....	98	...	97	.....	2						
Abscess of pharynx.....	3	1	2	.....	...	2	1	1	...	...	1
Foreign body in oesophagus.....	3	0	2	.....	...	2	2	1	1		
Stricture of oesophagus.....	1	0	0	.....	...	1	1	...	1		
Ulcer of mouth.....	2	0	2	.....	...	2	2	...	2		
Alveolar abscess.....	13	0	11	.....	...	2	2	...	2		
Pancreatitis.....	9	3	9	.....	...	6	6	4	2		
Abscess about rectum and fistula in ano.....	98	...	97	.....	1	61	46	14	26	6	

FOLLOW-UP SYSTEM IN A HOSPITAL SERVICE

Fissure of anus.....	4	0	4	114	4	3	3	45	3	
Hemorrhoids.....	191	0	184							
Prolapse of rectum.....	3	0	3	2	0	2	...	1	1	
Proctitis.....	1	0	1	3	0	2	...	2		
Stricture of rectum.....	4	0	2	1	1	1	...	1		
Ulcer of rectum.....	2	0	1	1	1	1	...			
Acute dilatation of stomach.....	1	0	1	0	0	0	...			
Gastritis.....	4	0	0	0	0	0	...			
Foreign body in stomach.....	1	0	0	0	0	0	...			
Hypochlorhydria.....	2	0	1	0	0	0	...			
Pyloric spasm.....	2	0	2	2	2	1	...	...	1	
Stenosis of pylorus.....	1	1	1	62	2	55	28	22	4	1
Ulcer of stomach and duodenum.....	93	7(1)	70							
Perf. ulcer.....										
Ulcer—stomach (2).....										
Carcinoma of stomach.....										
Revision of gastro-enterostomy.....										
Salpingitis.....										
Adhesions.....										
Neurasthenia.....										
Ulcer of stomach, perforating.....	40	11(1)	39	29	26	10	16			
<i>Ductless Glands and Spleen:</i>										
Exophthalmic goitre.....	12	2	9	8	5	1	3	1		
Simple cystic goitre.....	12	0	9	8	4	2	2			
Suppurative thyroiditis.....	1	0	1	1	1	...	1			
Diseases of spleen.....	11	1	9	6	6	4	1	...		1
<i>The Ear:</i>										
Otitis media and mastoiditis.....	16	0	8	13	8	4	4			
<i>The Eye:</i>										
Ulcer of cornea.....	1	0	0	1	0	0				
<i>Hernia:</i>										
Epigastric.....	4	0	4	4	3	...	2		1	
Femoral.....	54	1	53	46	40	27	10	3		
Ventral.....										
Inguinal hernia.....										
Relaxed pelvic floor.....										
Prolapse of uterus.....										

REPORT OF FOLLOW-UP WORK FROM FEBRUARY, 1913, TO DECEMBER, 1918, INCLUSIVE.—Continued

Diagnosis	No. of cases	No. of deaths	No. of operations	Readmitted	2nd operation	To return	Re-reported	Excellent	Satisfactory	Unsatisfactory	Died at home
<i>Hernie: Continued</i>											
Femoral, strangulated.....	11	1	11	Hernia, opposite side.....	10	9	9	5	4		
Inguinal.....	872	2	849	Recurrence.....	9	780	539	319	209	11	
				Cellulitis of wound (2).....	1						
				Tonsils.....	2						
				Hydrocele.....	2						
				Endothelioma of submaxillary nodes	0						
				Varicose veins.....	1						
				Carcinoma of bladder.....	1						
				Hemorrhoids.....	2						
				Acute appendicitis.....	3						
				Congenital malformation of testicle.	0						
				Tubercular vertebra.....	1						
				Inguinal abscess.....	1						
				Femoral hernia.....	1						
Inguinal, strangulated.....	41	6	41	Tubercular peritoneum.....	2	34	25	16	7	1	1
Umbilical.....	22	2	21	Strangulated hernia, opposite side..	1	17	14	4	9	1	
Umbilical, strangulated.....	9	5(1)	9	Fibroid uterus.....	0	4	3	...	2	...	1
Ventral.....	49	2	39	Inguinal hernia.....	1	2	26	17	8	1	
				Salpingitis.....	2	33					
				Tubercular vertebra.....	0						
				Hemorrhoids.....	1						
Ventral, strangulated.....	7	3(1)	5	Intestinal obstruction.....	Died	2	1	...	1		
<i>Infective Diseases:</i>											
Abscess.....	115	4	110	Abscess.....	4	73	52	20	25	5	2
				Chronic appendix.....	1						
				Tubercular vertebra.....	0						
				Tubercular peritonitis.....	Died						
Carbuncle.....	21	2	21	P. O. hemorrhage.....	...	8	7	3	4		
Cellulitis.....	100	5	90	Contracture.....	1	71	53	13	34	6	
				Abscess.....	1						
Erysipelas.....	2	0	0	...	0						
Furunculosis.....	5	0	5	3	3	1	2		

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REPORT OF FOLLOW-UP WORK FROM FEBRUARY, 1913, TO DECEMBER, 1918, INCLUSIVE.—Continued

Diagnosis	No. of cases	No. of deaths	No. of operations	Readmitted	2nd operation	To return	Re-reported	Excellent	Satisfactory	Unsatisfactory	Died at home
Lymphatic System: Continued.											
Lymphadenitis, tubercular											
Elephantiasis	2	1	2		0					1	
Hodgkin's	4	0	3		3	1	1	...	...	1	
Miscellaneous:											
Miscellaneous diseases	57	2	34		...	22	18	4	10	3	1
Muscles and Tendons:											
Diseases of muscles and tendons	20	0	16		...	14	12	9	3		
Nervous System:											
Diseases of nervous system	31	4	8		...	5	5	...	2	3	
Reproductive Organs (Female):											
Dysmenorrhœa	3	0	1		1	2	2	2			1
Metrorrhagia	4	0	2		1	3	3	...	2	...	
					1						
Sterility	1	0	0		...	0	0				
Galactocœle	1	0	1		...	1	0				
Hypertrophy of breast	1	0	1		...	0					
Mastitis	44	0	40		4	36	26	19	5	1	1
Pelvic cellulitis	3	1	3		1	2	2	1	1		
Extra-uterine gestation	52	3(1)	51		1	45	33	18	11	4	
					1						
					0						
					0						
Hæmatosalpinx	1	0	1		...	1	1	1			
Oophoritis	9	0	8		...	7	6	3	2	1	
Salpingitis, acute	47	3(1)	43		0	37	27	14	11	2	
					1						
					1						
					1						
					0						
Salpingitis, chronic	244	5	211		0	165	118	39	67	11	1
					0						
					1						
					1						

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CHARLES L. GIBSON

REPORT OF FOLLOW-UP WORK FROM FEBRUARY, 1913, TO DECEMBER, 1918, INCLUSIVE.—Continued

Diagnosis	No. of cases	No. of deaths	No. of operations	Readmitted	2nd operation	To return	Re-reported	Excellent	Satisfactory	Unsatisfactory	Died at home
<i>Reproductive Organs (Female):</i> Continued											
Vaginitis.....	2	0	0		1	0					
<i>Reproductive Organs (Male):</i> Phimosis and redundant prepuce..	73	0	68		0	25	20	18	2		
Abscess of prostate.....	5	0	4		...	2	2	1	...	1	
Hypertrophy of prostate.....	22	5	19		1	14	10	3	5	1	1
Abscess of scrotum.....	2	0	1		...	0					
Calculus of prostate.....	1	0	0		...	1	0				
Prostatitis.....	1	0	0		...	1	0				
Acute orchitis.....	1	0	0		...	0					
Hydrocele.....	65	0	62		2	45	31	20	10	1	
Varicocele.....	79	0	78		1	60	36	18	17	1	
Spermatocele.....	2	0	2		...	1	1	...	1		
Epididymitis.....	9	0	4		...	3	3	2	1		
<i>Parasites:</i> Entamoebic dysentery.....	1	0	1		...	1	1	1			
Echinococcus cysts liver.....	4	2	4		...	2	1	1			
Spleen.....	1	0	1		...	1	1	...	1		
<i>Respiratory System:</i> Abscess of lung.....	4	1	4		1	3	2	1	1		1
Suppurative pleurisy.....	96	14(1)	89		5	49	45	26	17	1	
<i>Lobar pneumonia</i> <i>Nasal Passages and Accessory Sinuses:</i> Sinusitis.....	2	2(1)	1		1 died	3	2	1	1		
	3	0	3		1	...	...	...	...	...	...

FOLLOW-UP SYSTEM IN A HOSPITAL SERVICE

[illegible]

REPORT OF FOLLOW-UP WORK FROM FEBRUARY, 1913, TO DECEMBER, 1918, INCLUSIVE.—Continued

Diagnosis	No. of cases	No. of deaths	No. of operations	Readmitted	2nd operation	To return	Re-reported	Excellent	Satisfactory	Unsatisfactory	Died at home
<i>Tumors (Benign): Continued</i>											
Fibromyoma of uterus.....	145	4	133	Carcinoma of uterus..... Cholecystitis..... Vulvo-vaginal abscess..... Adhesions..... Lacerated pelvic floor..... Constipation.....	1 1 2 1 0	108	81	34	38	4	5
Fibrolipoma.....	1	0	1	.....	...	1	1	1			
Lympho-angio-fibrolipoma.....	1	0	1	.....	...	1	1	1			
Osteochondroma.....	2	0	2	.....	...	2	2	1	1		
Unknown.....	3	0	0	.....	...	0					
<i>Tumors (Malignant):</i>											
Carcinoma of											
Appendix.....	2	1	2	.....	...	1	1	...	1		1
Bartholin's gland.....	1	0	1	.....	...	1	1	...	...		5
Bladder.....	10	2	7	.....	...	8	7	...	2	...	25
Breast.....	51	0	48	Recurrence.....	Died	50	41	...	12	4	4
Gall-bladder.....	6	2	5	.....	...	4	4	...	...	...	12
Intestines.....	33	11	25	Recurrence.....	1	21	14	...	1	1	
Larynx.....	1	0	1	.....	...	1	1	...	1		3
Liver.....	6	3	6	.....	...	3	3	...	...	...	3
Lymph nodes.....	6	0	5	.....	...	6	5	...	2	...	3
Maxilla.....	3	1	3	.....	...	2	1	...	...	...	1
Oesophagus.....	4	1	4	.....	...	3	2	...	...	...	2
Pancreas.....	7	4(1)	3	.....	...	3	3	...	...	...	3
Peritoneum.....	2	2	2	.....	...	3		...	...	...
Prostate.....	5	1	2	.....	...	4	1	...	...	...	1
Rectum.....	11	3(1)	7	.....	...	8	6	...	1	...	5
Stomach.....	40	11(1)	30	Recurrence.....	Died	28	22	...	4	...	18
Thyroid.....	2	1(1)	0	.....	...	1	0	...	...	...	2
Fallopian tubes.....	3	0	3	.....	...	3	2	...	...	...	19
Uterus.....	32	1	21	Recurrence.....	3 2 died	29	25	...	3	3	
Ovaries.....	5	2	5	.....	...	3	1	...	...	...	1

FOLLOW-UP SYSTEM IN A HOSPITAL SERVICE

[illegible]

REPORT OF FOLLOW-UP WORK FROM FEBRUARY, 1913, TO DECEMBER, 1918, INCLUSIVE.—Continued

Diagnosis	No. of cases	No. of deaths	No. of operations	Readmitted	2nd operation	To return	Re-reported	Excellent	Satisfactory	Unsatisfactory	Died at home
<i>Tumors, Malignant: Continued</i>											
Myosarcoma of Intestines.....	1	0	1	.....	...	1	1	...	1		
Myxochondro-endothelioma	2	0	2	.....	...	2	1	...	1		
Parotid.....	4	0	4	.....	...	4	1	...	1		
Submaxillary gland.....											
<i>Urinary Organs:</i>											
Abscess urethra.....	1	0	1	Fistula in ano.....	1	1	0	...	2		2
Calculus in bladder.....	6	0	4	Calculus.....	Died	3	2	...	2		
Cystitis.....	16	2	3	Pulmonary tuberculosis.....	0	5	4	...	3	2	
Calculus in ureter.....	10	0	4	.....	1	6	6	...	2		
Calculus in urethra.....	2	0	2	Stricture of urethra.....	1	2	2	...	1		
Caruncle of urethra.....	1	0	1	.....	...	1	1	1	1		
Cyst of kidney.....	2	0	2	.....	...	2	2	1	1		
Hæmaturia.....	3	0	3	.....	...	2	1	1	1		1
Hydronephrosis.....	2	0	2	.....	...	2	2	...	1		
Incontinence.....	1	0	0	.....	...	0	0				
Leukoplakia of bladder.....	1	0	0	.....	...	1	0				
Nephralgia.....	1	0	0	.....	...	0					
Nephritis.....	10	5(4)	6	.....	...	4	3	13	9	1	1
Nephrolithiasis.....	42	2	26	Hæmaturia.....	0	28	23				
				Nephrolithiasis.....	1	1	7				
				Pleurisy.....	0	7	19	3	2	1	
Nephroptosis.....	10	0	7	.....	...	26	5	14	3	2	
Perinephritic abscess.....	30	2(1)	28	.....	...	9	5	1	4		
Pyelitis.....	16	0	2	.....	...	0					
Retention of urine.....	2	1	1	.....	...	2	10	3	4	2	1
Stricture of urethra.....	31	1	29	Fistula in ano.....	2	21					
				Acute appendicitis.....	1	2	2		2		
Stricture of ureter.....	4	0	4	.....	...	1					
Stricture neck of bladder.....	1	0	1	.....	...	1	1		1		
Ureteral colic.....	4	0	0	Abscess prostate.....	0	4	4		3		
<i>Obstetrical Conditions:</i>											
Abortion, incomplete.....	102	0	99	Acute cystitis.....	1	66	44	11	27	5	1

FOLLOW-UP SYSTEM IN A HOSPITAL SERVICE

[illegible]

REPORT OF FOLLOW-UP WORK FROM FEBRUARY, 1913, TO DECEMBER, 1918, INCLUSIVE.—Continued

Diagnosis	No. of cases	No. of deaths	No. of operations	Readmitted	2nd operation	To return	Re-reported	Excellent	Satisfactory	Unsatisfactory	Died at home
<i>Injuries: Continued</i>											
Gunshot wound of											
Radius.....	1	0	1	.....	...	1	0	...	1		
Scapula.....	1	0	1	.....	...	1	1				
Dislocation of											
Ankle.....	2	0	1	.....	...		2	2		1	
Cartilage.....	7	0	6	.....	...		7	3	3		
Elbow.....	11	0	4	.....	...	7	7	1	6		
Inferior maxilla.....	1	0	0	Arthritis.....	1	1	1	...	1		
Metatarsals.....	1	0	0	.....	...	1	1	...	1		
Metacarpals.....	1	0	1	.....	...	1	1	...	1		
Hip.....	1	0	0	.....	...	1	1	...	1		
Radius.....	1	0	0	.....	...	1	1	...	1		
Ribs.....	1	0	1	.....	...	1	1	...	1		
Humerus.....	20	0	6	Fracture of humerus.....	0	11	7	1	4	2	
Wrist.....				Dislocation.....	0						
Foreign body in	5	0	2	.....	...	2	2	1	0	1	
Joint.....	8	0	8	.....	...				
Bursa, prepatellar.....	1	0	1	.....	...	5	5	...	4	1	
Sprain of				.....	...	1	1	...	1		
Sacro iliac joint.....	2	0	0	.....	...	1	1	1	1		
Synovitis, traumatic.....	3	0	1	.....	...	1	1	...			
Contusion of				.....	...				
Joint.....	3	0	0	.....	...	0					
Punctured wound				.....	...				
Knee.....	2	0	2	.....	...	1	1	...	1		
Injuries to				.....	...				
Digestive system.....	29	11(1)	19	Cystoma.....	1	13	10	4	5	...	1
Ear.....	2	0	2	.....	...				
Muscular system.....	37	0	37	Pelvic abscess.....	1	33	31	2	25	4	
Nervous system.....	5	1	2	.....	...	0					
Reproductive organs.....	5	0	2	.....	...	4	3	3			
Respiratory system.....	4	1(1)	2	Bronchiectasis.....	Died	2	2	2			
Spleen.....	2	0	2	Ventral hernia.....	1	2	1	1			

FOLLOW-UP SYSTEM IN A HOSPITAL SERVICE

Urinary organs.....	4	1	2	1	2	1	1	1	2				
Abdominal wall.....	11	3(1)	9	1	6	5	3	3	3				
Back.....	12	1(1)	7	1	5	3	3	3	3				
Chest wall.....	4	1(1)	1	1	2	2	2	2	1			1	1
Extremities, lower.....	42	2	20	2	24	15	4	4	10			1	1
Extremities, upper.....	61	2(1)	49	1	45	37	22	12	12			3	3
Face and scalp.....	25	1(1)	10	1	10	8	3	3	4			1	1
Neck.....	4	0	3	0	1	1	1	1	1			1	1
Pernum.....	2	0	1	1	2	2	2	2	2			1	1
Miscellaneous and multiple injuries	20	7(5)	8	1	7	6	5	5	5			1	1
Readmission	8028	358	6808	367	5707	4324	1921	1827	393			183	183
Total	428	27	367										
	8456	385	7175										

(Of this number 27 died)

* Under "Number of Deaths," figures in parentheses denote number included in other figures who died without operation. Of the 358 cases who died in the Hospital, therefore, 60 of these had no operation. Operative mortality, 4 per cent.
 NOTE.—Total number of known deaths, both in and out of Hospital, 508. (Of this number 3 patients died of influenza after leaving the hospital.) Therefore of 8028 cases 7 per cent. are known to be dead.
 NOTE.—Of 5707 cases asked to return for examination 75.5 per cent. returned. This percentage is lowered by the inclusion of the two unsatisfactory periods, i.e., the year 1913 and the period of the war. Our percentage under normal conditions has been as follows: Mar. 11, 1916 (three months report), 93 per cent.; September, 1916 (six months report) 90.6 per cent.; Dec., 1916 (three months report), 88.7 per cent.; April, 1917 (three months), 90.6 per cent.

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APPENDIX

CLASSIFICATION OF PATIENTS RETURNING FOR SECOND OPERATION *

Malformations:	No. of cases	No. of deaths
Harelip	1	1
Spinal column	1	
Bones and Cartilages:		
Faulty union	8	
Osteomyelitis	12	
Bursitis	1	
The Circulatory System:		
Aneurism	1	
Endarteritis	3	
Varicose veins	3	
The Digestive System:		
Acute appendicitis	5	
Chronic appendicitis	4	
Fecal fistula	3	
Intestinal obstruction	2	2
Abscess of liver	1	
Cholelithiasis	4	1
Stenosis of gall-bladder	1	1
Pelvic abscess	3	
Adhesions of peritoneum (P. O.)	13	
Tonsils and adenoids	12	
Abscess about rectum	4	
Fistula in ano	13	
Fissure of anus	1	
Stricture of rectum	1	
Hemorrhoids	6	
Gastroptosis	2	
Gastric ulcer	2	
Gastric ulcer, perforating	1	1
Duodenal ulcer	1	1
Ductless Glands and Spleen:		
Exophthalmic goitre	1	
Banti's disease	1	1
Splenomegaly	1	1
Herniæ:		
Femoral hernia	1	
Inguinal hernia	26	
Inguinal hernia, strangulated	3	
Ventral hernia	22	1
Umbilical hernia	1	
Infective Diseases:		
Abscess	13	
Cellulitis	4	
Syphilis	1	
Tuberculosis of intestines	1	1

* The second operation is often for a condition different from the original disease, *e.g.*, hemorrhoids following chronic appendicitis. The patient's history card is filed under the original condition for which he entered the hospital. Subsequent admissions are entered on the same card, second diagnoses being cross referenced.

FOLLOW-UP SYSTEM IN A HOSPITAL SERVICE

Infective Diseases (Continued):

Tuberculosis of (continued):	No. of cases	No. of deaths
joints	8	
bones	4	
peritoneum	5	I
costal cartilage	I	
skin	I	
epididymis	2	
fallopian tubes	I	
properitoneal tissue	I	
kidney	I	
lymph nodes	23	
Appendix	I	
Joints:		
Ankylosis	3	
Arthritis ..	3	
Talipes	I	
Miscellaneous:		
Abdominal sinus	3	
Foreign body in abdominal sinus	I	
P. O. wound	I	
Foreign body in abdominal wall	I	
P. O. hemorrhage	I	
Cicatricial contracture	2	
Ganglion	I	
Hæmatoma	I	
Revision of amputation stump	I	
Foreign body in thigh	I	
Skin grafting	I	
Parasites:		
Actinomycosis of colon	I	I
Reproductive Organs (Female):		
Metrorrhagia	I	
Mastitis	4	
Extrauterine gestation	I	
Chr. salpingitis	16	
Anteflexion of uterus	I	
Retroversion of uterus	I	
Prolapse of uterus	2	
Anteversion	I	
Relaxed pelvic floor	3	
Lacerated pelvic floor	2	
Endometritis	7	
Endotrachelitis	I	
Vulvo-vaginal abscess	2	
Reproductive Organs (Male):		
Circumcision	2	
Hydrocele	5	
Respiratory System:		
Suppurative pleurisy	5	
Abscess of lung	2	I
Bronchiectasis	2	I
Skin, Hair and Nails:		
Ulcer of leg	I	

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	No. of cases	No. of deaths
Tumors (Benign):		
Adenoma of thyroid	1	
Cystoma of ovary	8	
Fibromyoma of uterus	7	
Teratoma	1	
Lipoma	2	
Osteoma	1	
Tumors (Malignant):		
Carcinoma of gall-bladder	1	1
Carcinoma of stomach	2	2
Carcinoma of bladder	1	
Carcinoma of breast	1	1
Carcinoma of uterus	4	1
Epithelioma of uterus	1	
Epithelioma of tongue	3	
Carcinoma of intestines	1	
Sarcoma of bones	2	1
Sarcoma of breast	1	1
Sarcoma of kidney	1	1
Sarcoma of omentum	1	1
Urinary Organs:		
Pyonephrosis	1	
Stricture of urethra	4	
Calculus in ureter	1	
Calculus in bladder	1	1
Nephrolithiasis	1	
Acute cystitis	1	
Obstetrical Conditions:		
Incomplete abortion	4	
Injuries:		
Lacerated wound of tendon	1	
Fracture of femur	1	1
Total	367	27

WAR SURGERY UNDER FRONT-LINE CONDITIONS*

REPORT OF THE WORK OF CASUAL SURGICAL TEAM NO. 506 (ORIGINALLY NO. 6) FROM JUNE 18, 1918, TO AUGUST 8, 1918

By ELLIOTT C. CUTLER, M.D.

OF BOSTON, MASS.

CAPTAIN MEDICAL CORPS, A. E. F.; CHIEF OF TEAM

PERSONNEL OF CASUAL SURGICAL TEAM NO. 506 (NO. 6): CAPTAIN ELLIOTT C. CUTLER, MEDICAL CORPS; CAPTAIN CARLETON METCALF, MEDICAL CORPS; FIRST LIEUT. PAUL B. STEELE, MEDICAL CORPS; LILLIAN E. BOWEN, R.N., A.N.C.; MARY A. OWENS, R.N., A.N.C.; PRIVATE LOUIS WISCHMAN, MEDICAL DEPARTMENT; PRIVATE HENRY C. WARD, MEDICAL DEPARTMENT

Foreword.—The following is a summary of the work performed by Casual Surgical Team No. 6 (No. 506 as per new orders) from June 18, 1918, to August 8, 1918. During this period we have records of 576 cases operated upon by the team. Presumably about 50 to 75 more cases were operated without our ever obtaining any records. The period covers two distinct periods of military activity.

During the first period from June 18 to July 15, 1918, the team was working in Evacuation Hospital No. 7 and Mobile Hospital No. 1, which were established as a single group at Coulommiers, France. The cases arriving at these two hospitals during this period came in successive groups, usually covering two to three days, due to efforts of the American troops in the line to dislodge the enemy from a difficult wooded country and to straighten out and improve their battle front. At no time was the influx of patients great enough to overtax the ability of these two hospitals to handle them well, and as a result careful and deliberate operations were almost always possible.

The second period began July 15, with the general attack of the enemy along the Marne River. From this date on, until the closure of these records with our transfer to Evacuation Hospital No. 3 as Surgical Director, the

* EDITOR, ANNALS OF SURGERY:

I am directed by the Surgeon General to say that the inclosed paper, "Report of the Work of Casual Surgical Team, No. 506, etc.," is authorized for publication. It is thought that if published in full, it would be interesting as a typical A. E. F. Team report.

LOY McAFEE,

Contract Surgeon, U. S. Army,
Secretary, Board of Publications.

September 29, 1919.

pressure of work was great and excessive almost without respite. We were moved July 31 to the southern bank of the Marne, east of Château-Thierry, where we continued to work in Mobile Hospital-No. 1 until we were moved to Evacuation Hospital No. 3 at Crezancy August 8, 1918. There was one period of twenty-four hours' continuous work, two hours' sleep, and then twenty-four hours' more work. It was a most trying experience and I take the greatest pleasure in attesting here to the energy, ability, devotion to duty, and zeal of the assistants, officers, nurses, and enlisted men. Their conduct throughout was exemplary and worthy of the highest praise.

Captain Carleton R. Metcalf, since promoted to the rank of major, was an excellent assistant, and since we have been attached to Evacuation Hospital No. 3, has carried on the work of the team as operator. He is a skillful and experienced surgeon, capable and of good judgment. Lieut. Paul B. Steele, the anæsthetist, but now assistant to Major Metcalf, was equally untiring in his devotion to his work and has already proved himself a capable assistant. He deserves promotion. The two nurses, Miss Mary Owens and Miss Lillian Bowen, cannot receive too much praise. They endured great physical hardships and "carried on" when utterly fatigued time and again without any thought or question of themselves. Their ability as operating team nurses is of the highest merit, and after seventeen months in France I can earnestly say that I have never seen two women better adapted to their work. The enlisted men acting as orderlies, Privates Wischman and Ward, had had no previous training; one having been a fireman on a locomotive and the other a "section hand." Both had recently arrived in France. Both rapidly fitted into their new position and one, Private Ward, became an exceptionally proficient operating room orderly. Their behavior was always correct, their devotion to the team a source of the greatest satisfaction, and their willingness to work at all times a great credit to themselves. Unfortunately, Private Ward sustained severe injuries to both hands August 12, from the bursting of a hand grenade, and after operation was evacuated to the Base.

Again, before placing the following summary before you, let me beg indulgence for the incompleteness of the report. Anyone who has been through a long service of this kind of work will realize the difficulty under so much pressure of making careful records and of obtaining any real figures on results. Further, if they are consistently busy they will have found how extremely difficult it is to correlate and summarize even the bare facts which they may have to present. In going over our records I find that what we have chiefly to present is an anatomical summary of the kind and distribution of wounds received. Careful studies are being made of some of the groups in which we are especially interested and about which we hope to make a more elaborate report later on.

A. FIRST PERIOD.—*June 18 to July 18* (this runs into the second period of military activity beginning with the Battle of the Marne, July 15, 1918).

WAR SURGERY UNDER FRONT-LINE CONDITIONS

INJURIES TO THE HEAD

Group	I. Scalp wounds	13 cases.
	(9 closed by suture, 4 partial closure.)	
Group	II. Fracture without dural penetration	5 cases.
	(3 closed by sutures, 2 partial closures.)	
Group	III. Fractures with dural penetration and depression without extrusion of brain	2 cases.
	(1 closed by sutures, 1 partial closure.)	
Group	IV. Gutter type, with brain extruding and indriven fragments of bone	1 case.
	(1 case closure by suture.)	
Group	V. Penetrating type, with indriven bone plus metal ...	1 case.
	(missile removed, closed by sutures.)	
Group	VI. Ventricles opened	0 cases.
Group	VII. Craniofacial wounds opening sinuses	1 case.
	(Partial closure, rubber tissue drain.)	
Group	VIII. Perforating wounds	0 cases.
Group	IX. Bursting fractures	1 case.
	(Closure.)	
Total cases		24
Total deaths (known of)		2
(Group IV, 1; Group IX, 1.)		
Mortality, 8.6 per cent.		

Discussion.—During the first period very few “head” wounds came through to the centre in which we were working because a field hospital further up the line had been fitted with surgical equipment and teams, and was taking all non-transportable cases, among which “head” cases were included. We employed the technic initiated by Lieut. Col. Harvey Cushing, under whom we had had the opportunity of being trained in such work, and our results were satisfying. The careful preparation and method of operation under local anæsthesia were strictly adhered to even in the simplest cases. At first, with a team untrained in such work, the operations went slowly and seemed cumbersome, but with practice things went more smoothly and the results, to those who are familiar with such work, were gratifying.

The two deaths follow: (1) A gutter wound low in the left temporal region with a punctured dura and indriven bone fragments; patient developed meningitis (streptococcus) and died on the tenth day; we have felt this might have been avoided by better technic. It was the first head case done by the team.

(2) A bursting fracture with multiple cracks running from the vertex to the base. Patient was side-swiped off a truck and was admitted unconscious. A decompression was done. Patient died in four hours.

ELLIOTT C. CUTLER

INJURIES TO THE ABDOMEN

(1) Wall only	2 cases.
("Débridement.")	
(2A) Penetrating wounds, with perforation of intestines	1 case.
(Suture of multiple holes, no gut resected; closure.)	
(2B) Penetrating wounds, without perforation of intestines	1 case.
("Débridement," closure abdomen, skin not sutured.)	
<hr/>	
Total cases	4
Deaths	0

INJURIES TO THE CHEST

(1) Injuries to chest wall only: (a) Without fracture ribs	7 cases.
(b) With fracture ribs	1 case.
("Débridement," removal broken ends of bone.)	
(2) Penetrating injuries: (a) Without fracture ribs	1 case.
(b) With fracture ribs	2 cases,
("Débridement," removal broken bits of ribs. One case— foreign body removed.)	
(3) perforating wounds (with fracture ribs)	1 case.
<hr/>	
Total cases	12
Total operations (penetrating and perforating cases)	2
Deaths	0
1 case reoperated for drainage after primary closure.	

COMPOUND INJURIES CHEST, DIAPHRAGM AND ABDOMEN

1 case—Perforation of chest wall, lung and diaphragm; missile lodged in liver; no operation; recovery.	
2 cases—Perforation chest wall, lung, diaphragm; missile lodged in abdomi- nal cavity.	
Operations	2
Deaths	2
(One gas infection, liver; other bowel and kidney lesion.)	

All cases of injury to head, chest or abdomen were held at least seven days for observation, and all that were evacuated left the hospital in good shape.

NERVE SUTURES

Ulnar	1
External peroneal	1

BLOOD-VESSEL LESIONS

1 case—Ligation subclavian artery for traumatic injury axillary artery; transfusion; evacuated in satisfactory condition.	
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WAR SURGERY UNDER FRONT-LINE CONDITIONS

SOFT PART INJURIES

	Shell wounds	Rifle or machine-gun bullets
Face	15	0
Eyes	2	0
Neck	4	0
Back	13	0
Arm	33	4
Forearm	16	0
Hand	12	3
Buttock	15	0
Thigh	35	1
Leg	35	1
Knee (superficial)	4	0
Foot	8	2
Total	192	11

Deaths—2. (See under summary of deaths.)

Discussion.—The usual operative procedure followed was to make long incisions parallel to muscle fibres, to “débride” the tract as thoroughly as possible and then to cover the wound with a piece of gauze wet in Carrel-Dakin fluid, after protecting the skin edges by strips of vaseline gauze. More rarely gutta-percha strips were laid in for drainage and to protect against painful subsequent dressings. Still less frequently Carrel-tubes were inserted, and these were not used unless it was our intention to detain the case in the hospital for several days in order to observe its future course. In the early part of this first period some primary sutures were attempted, with, so far as our observations in detained cases and from the results of returned post-cards went, good success. After July 1, 1918, this procedure was prohibited by order.

INJURIES WITH FRACTURES

(Exclusive of skull and joint injuries)

	Shell wounds	Rifle or machine-gun bullets
Spine	1	0
Pelvis	3	0
Scapula	3	0
Humerus	2	1
Forearm	3	1
Hand	6	5
Femur	2	1
Leg	10	0
Foot	7	7
Total	37	15

Deaths—2. (See under summary of deaths.)

Discussion.—The procedure with fractures was the same as with soft parts: wide thorough "débridement" through long incisions. The operation was invariably performed with the member in extension. Small fragments of bone, unless deemed essential, were as a practice removed. The apparatus was applied immediately, and we always made it an especial point to see that it was properly applied, with good traction and the correct amount of flexion maintained where joints were concerned.

Fracture cases were more often detained in the hospital than soft part injuries, and Carrel-tubes were more often used, and in our opinion provide a decided help in combating the infection which in some cases is certain to be present, no matter how thorough the original operation.

INJURIES TO JOINTS

Knee.....	5	Penetrating shell wounds, soft part only.
	1	Perforating shell wound, with fracture.
	3	Penetrating shell wounds, with fracture.
	1	Perforating bullet wound, with fracture.
Shoulder.....	1	Penetrating shell wound, soft parts only.
	1	Perforating shell wound, with fracture.
Elbow.....	3	Perforating shell wounds, with fracture.
Wrist.....	1	Penetrating shell wound, soft parts only.
Phalangeal....	Many,	since in most of the hand and foot injuries joints were opened or blown out.
Ankle.....	2	Perforating shell wounds, with fracture.
	2	Perforating bullet wounds, with fracture.
<hr/>		
Total.....	20	cases.

Discussion.—The above group of cases have especially interested us for we have come to believe that in this branch of surgery the war has given us more advance than in any other. After an opportunity to study the surgery of joints, in a Belgian hospital, we have consistently practised the mobilization of joints as a principle in the treatment of injuries to joints. Cases thus treated have resulted satisfactorily in almost every instance. Naturally there are cases so disabling that motion cannot be employed and in certain joints its use is questionable; but always, when possible, we instituted active motion immediately following the operation. This principle was in practice chiefly applied to injuries to the knee-joint. Injuries to this joint, whether involving bone or only soft parts, were treated alike. Where the soft parts only are injured, usually cases of perforating wounds, we excised the wounds, left the synovia open, instituted motion at once, walking on the second day, and in three or four days practised secondary closure after smear and culture control of the wound flora. At first we tried motion after immediate closure of such wounds, but a synovitis always ensued and this practice was discontinued. This method gave us a physically "fit" man at the end of ten days, walking

WAR SURGERY UNDER FRONT-LINE CONDITIONS

about, with full motion in his joint, who within two weeks more should have been ready for duty. The method of immediate closure followed by immobilization cannot hope to bring a patient back into service within such a short space of time.

The more disabling type of injuries to joints, with a bony lesion, were treated on the same principle. Operations were done with scrupulous technic and through a bloodless field by use of an Esmarch bandage and tourniquet. The patella reflexion incision was only used when necessary, for this incision obviates the possibility of early motion. At the same time, if it was necessary, in order to properly see the entire field, this incision was made without compunction. For in no other field of war surgery is a complete knowledge of the course of, and the extent of, the lesion caused by the missile so essential to a successful result. The missile and all portions of the tract were in each case chiselled away freely. If the patella tendon had not been cut and if enough articular surface remained to permit of motion, the synovia was not closed and motion instituted at once. If motion was impossible the synovia and joint were closed in layers and a splint applied for immobilization.

In one case we were forced to do a resection. Because of subsequent infection this leg was later amputated. In six of the knee cases, the joint fluid showed bacteria before operation. All cases except the above resection left the hospital in good shape, and those which had been mobilized with at least a fair range of motion and an uninfected joint. Four knee-joints were closed by suture on the fourth or fifth day and went on without trouble to a satisfactory convalescence. No drainage tubing was ever used.

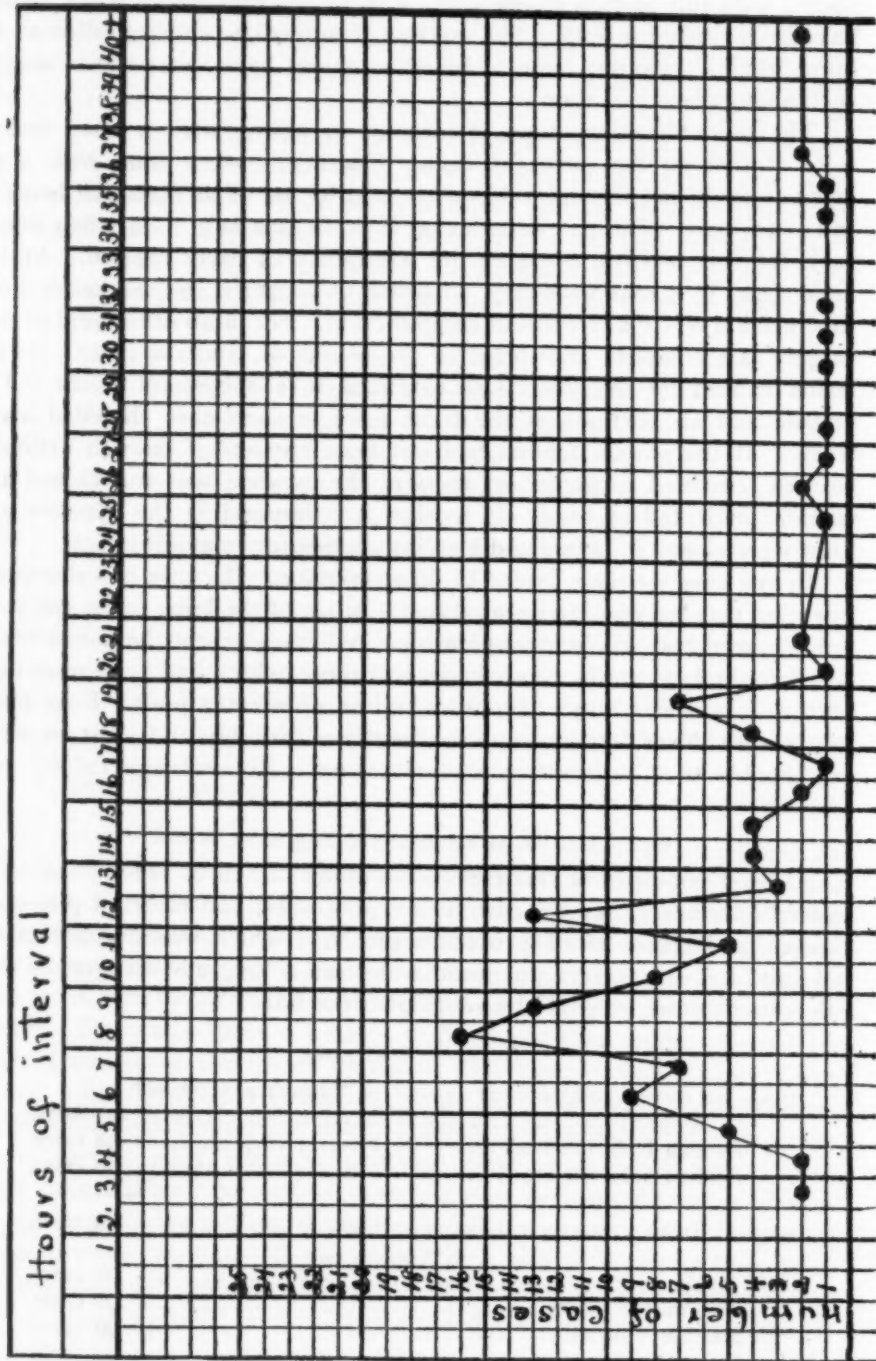
WORK OTHER THAN BATTLE CASUALTY WORK

At least ten cases of this type came under our care. There were two appendicitis cases, several carbuncles, abscesses, and infected pilo-nidal sinuses, and a case of streptococcus pleurisy, which was drained at the tail end of a very severe pneumonia and ran a long and dangerous convalescence before he could be sent down the line.

GENERAL SUMMARIES

(A) No foreign body present (gutter or through and through wounds)	127 cases.
Foreign body removed	98 cases.
Foreign body not found	19 cases.
Total	244 cases.
(B) Single injury	138 cases.
Two missile injury	36 cases.
Multiple injuries	34 cases.
No operation	35 cases.
Total	243 cases.

(C) INTERVAL IN HOURS FROM INJURY TO OPERATION



WAR SURGERY UNDER FRONT-LINE CONDITIONS

The interval of time between being wounded and operation was not always obtained. However, the chart shows graphically that the maximum number were operated upon within ten or twelve hours of the time at which they were wounded. This is certainly not a desirable interval.

(D) METHODS OF CLOSURE AND DRESSING OF WOUNDS

(a) Closure.

1. Primary closure	47
2. Partial closure with silkworm-gut drain	18
3. Partial closure with rubber tissue or gutta-percha	37

(a) Total 102

Discussion.—Of the primary closure wounds, and in this group one may include those with a few silkworm-gut strands for a drain, twenty healed uneventfully as reported by the seventh day; four were partial failures; two were complete failures. The partial closures with rubber tissue drains should not enter into a discussion of the primary suture cases. This leaves sixty-five sutured cases with twenty complete successes known of. Insufficient data forbid any deductions being drawn either way.

(b) No closure.

1. Carrell-Dakin tubes	41
2. Gauze wet in Carrell-Dakin fluid	134

(b) Total 175

Total (a) and (b) 277

(This is an aggregate of wounds, not cases. One patient with multiple wounds may require different treatment for the separate wounds.)

(E) DAILY NUMBER OF OPERATIONS (See Chart, page 704)

Total cases in first period, 260 cases. On duty during first period, 24 times. Average number of operations per tour of duty, 10.8.

RESULTS.—The account which follows is completed from evidence obtained by use of post-cards returned by the patient or personal observation. It is meagre and permits of no discussion or deductions.

(A) *At Twenty Days.*—Healed wounds, 34; improved, 37; secondary operations, 3.

(B) *Amputations.*—1. Secondary amputation right leg for infection; case originally operated at a Field Hospital.

2. Secondary amputation thigh for gas infection; five days after original operation (not originally operated by this team).

3. Secondary amputation thigh for infection following resection knee.

4. Primary amputation leg for compounded tibia, gas infection and divided posterior tibial artery (eighteen hours after injury).

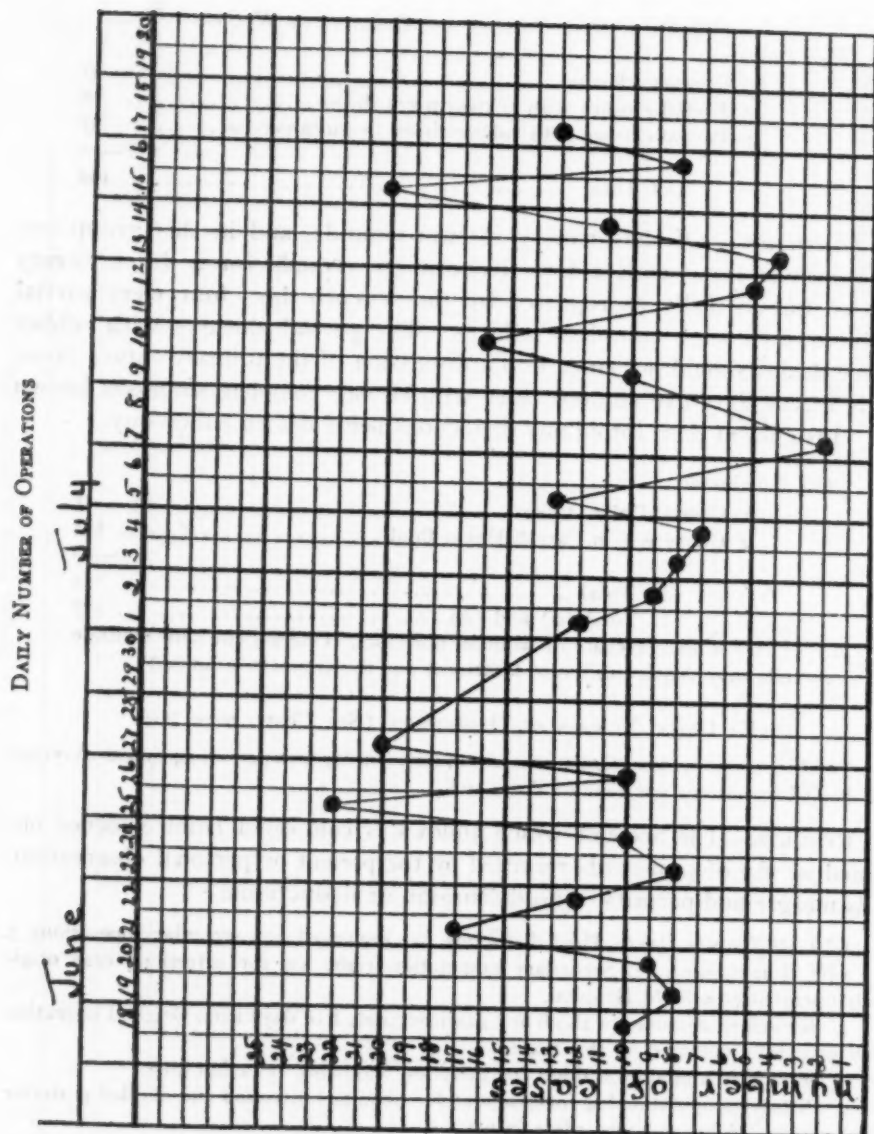
5. Primary amputation thigh for gas infection involving knee-joint and leg. (German prisoner, forty hours' interval.)

6. Primary amputation forearm; tourniquet on for fourteen hours.

7. Primary amputation thigh for gas gangrene.

8. Double amputation legs, primary, for gas gangrene.

9. Multiple amputations fingers and toes.



WAR SURGERY UNDER FRONT-LINE CONDITIONS

(C) *Deaths*.—1. (F.) Fracture, compound, skull; usual operation, closure, died tenth day, meningitis.

2. (C) G. S. W., left arm and right leg; "débridement," died third day, broncho-pneumonia.

3. (B) Superficial wound, shoulder; badly gassed. Died tenth day, pneumonia and severe mustard burns.

4. (K) Fracture compound, skull; bursting type, basal fracture, accidental, decompression. Died in four hours.

5. (H) Multiple wounds, face, scalp, lower arm and forearm, groin, scrotum, left thigh and leg, sucking chest wound perforating diaphragm to abdomen. Chest, diaphragm, abdomen operation. Died in four hours. Foreign body found in kidney.

6. (W) G. S. W., multiple, both legs; amputation left, incision and drainage right; shock. Died in two days.

7. (A) G. S. W., chest; chest-diaphragm, liver operation; gas infection. Died second day. Jaundiced before operation.

8. (W) G. S. W., both legs; double amputation for advanced gas infection. Died in ten hours.

Mortality.—Eight deaths in 260 cases—3.07 per cent.

B. SECOND PERIOD.—*Summary.*—July 18 to August 8, 1918 (the second Battle of the Marne).

INJURIES TO THE HEAD.

Group	Number of cases	Primary closures	Closures with small gutter-percha drain
I	13	13	0
II	5	2	3
III	1	1	0
IV	3	1	2
V	6	3	3
VI	3	0	3
VII	4	0	4
VIII	2	0	2
IX	0	0	0
	Total . . 37		

Deaths..... 4	{ Basal fracture without wound.....	1 case.
	{ Group VI.....	2 cases.
	{ Group VIII.....	1 case.
Mortality	10.8 per cent.	

Mortality 10.8 per cent.

Discussion.—The same technic was employed as in the first series. The lesions in this series were of a far more serious nature, and, indeed, about six cases were brought to the table moribund and inoperable. These have not been placed on this list; also several cases partially operated at field hospitals further up the line were brought to our care in a serious condition. In only one of these cases was a further operation adjudged advisable and this proved fruitless.

This may not be the appropriate place for this expression of opinion, but we feel forced to say this of head cases: Unless a surgeon thoroughly familiar with this field of surgery is available in the most forward areas, it would seem to us advisable to transport such cases further back where men trained in this field may be found. Head cases stand transportation

infinitely better before operation than after it. Also, when such cases are operated we believe that the entire operation should be done and no half-way measures permitted. Failure, chiefly due to infection, has invariably followed any attempt at half-way measures. This may mean the necessity of very long transportation before operation. Even so, we think that would be safer than partial operation, or operation by untrained hands.

INJURIES TO THE ABDOMEN

1. Wall only, without lesion of peritoneum	5 cases.
2. Penetrating wound, with perforation of intestines	4 cases.
Total	9 cases.
Deaths	1 case.

Discussion.—Of the latter group (2), one died in two hours; missile had fractured femur and passed upwards, literally tearing the bowels to pieces; should not have been opened, and was closed without any attempt to repair. The other cases, after repair of multiple lesions, made a successful convalescence until evacuated. One case was drained for pelvic peritonitis, but progressed favorably from the beginning; the other cases were closed without drainage. One case in which there had been an extensive laceration of the liver was reopened and the abdomen emptied of at least one liter of almost pure bile; convalescence uneventful and successful without any further intervention.

INJURIES TO THE CHEST

1. Injury to chest wall without fracture of rib and without penetration to pleural cavity. (In some the pleura was torn.)	10 cases.
2. Perforating wounds without fracture ribs	7 cases.
3. Penetrating wounds: (a) with fracture ribs	3 cases.
(b) without fracture ribs.....	9 cases.
Total	29 cases.
Deaths	None known of.

Discussion.—Of the nineteen perforating and penetrating cases, only three cases were operated, *viz.*, two of the cases with fractured ribs and one with a large and easily available foreign body. Experience made us more and more convinced that a majority of the lung cases do better without immediate exploration.

Compound Injuries to Chest, Diaphragm and Abdomen.—One case, which perforated, emerging close to spine, no operation at first, later with increasing distention and vomiting; abdomen opened, great quantity of bile, free of bacteria, drained away; recovery.

Nerve Sutures.—Ulnar, 2; median, 1; sciatic, 1; musculospiral, 1.

Blood-vessel Lesions.—1. Traumatic division axillary artery—ligation third portion subclavian under novocaine; died third day, gas infection.

2. Traumatic division femoral artery, fracture femur, gas infection—amputation.

WAR SURGERY UNDER FRONT-LINE CONDITIONS

3. Traumatic division occipital artery—tied vessel in wound after "débridement."

4. Traumatic division posterior tibial artery, G.S.W. with fracture fibula, tourniquet in place; apparent return of circulation after removal tourniquet—ligature, "débridement;" on second day amputation for gas infection.

5. Traumatic division axillary artery and vein—ligatured, O.K., when evacuated second day following operation.

WOUNDS WITH INJURIES TO SOFT PARTS

	Shell wounds	Bullet wounds
Face	14	1
Eyes	2	0
Neck	2	2
Shoulder	11	3
Arm	10	7
Forearm	3	5
Hand	7	8
Buttocks	11	8
Thigh	24	10
Scrotum and pelvis	1	1
Leg	26	2
Foot	8	4
Back	5	4
Total	125	55

Discussion.—The same technic of wide incision and thorough "débridement" used in the first period was adhered to. But in this period, because of increased experience, our work was probably of a much better kind and certainly we were more facile.

INJURIES WITH FRACTURES (Exclusive of Skull and Joint Lesions.)

	Shell wounds	Bullet wounds
Face	3	3
Shoulder girdle	5	1
Arm (humerus)	8	3
Forearm	1	0
Hand	3	0
Femur	5	4
Leg	5	4
Foot	1	1
Spine	2	3
Total	33	19

ELLIOTT C. CUTLER

Discussion.—Again we followed the same technic of operation and dressings used in the first period, even greater care being devoted to correct and adequate splinting. And with increased experience we remained fully as conservative insofar as amputation is concerned.

INJURIES TO JOINTS

Knee	{	2 Penetrating S. W. soft parts only.
		3 Perforating S. W. soft parts only.
		3 Penetrating S. W. with fractures.
		3 Penetrating S. W. with fractures.
		2 Perforating bullet wounds, soft parts only.
Shoulder	{	1 Penetrating S. W. soft parts only.
		1 Perforating S. W. with fracture.
Elbow	{	2 Perforating S. W. soft parts only.
		1 Perforating S. W. with fracture.
		1 Perforating S. W. with fracture.
Total		19 cases.

Discussion.—See under first series; it was so difficult to detain my cases this period that the treatment of joints became most unsatisfactory. Mobilization was instituted and full notes sent along with each case advising that this method be continued. Also, each patient was impressed with the importance of this procedure.

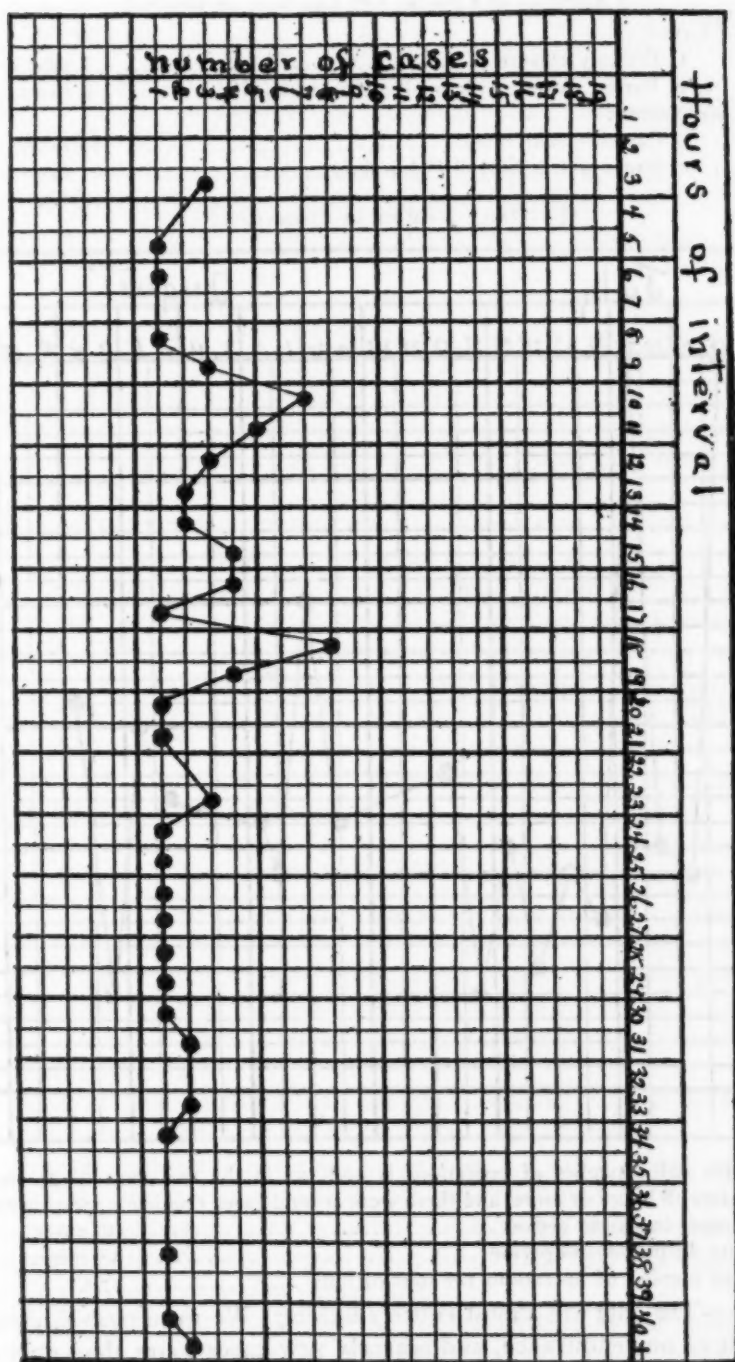
GENERAL SUMMARIES

(A) No foreign body present (gutter or perforating wounds) ..	138 cases.
Foreign body removed	74 cases.
Foreign body not found	5 cases.
Total	217 cases.
(B) Single missile injury	143 cases.
Two missile injury	25 cases.
Multiple missile injury	38 cases.
Total	206 cases.

(C) INTERVAL IN HOURS FROM INJURY TO OPERATION (SEE CHART, PAGE 709).

The interval of time between being wounded and operated was obtained in only a minority of the cases. Throughout this period our records are in places very fragmentary, so great was the pressure of work. But it is certain that the interval before surgical treatment was given became very extended; probably fifteen hours would be a low average. With the beginning of the Marne battle this was due to the fact that the number of cases admitted to the two hospitals at Coulemmiers was excessive and then later in the battle transportation became difficult, was insufficient, and the distance became very great.

WAR SURGERY UNDER FRONT-LINE CONDITIONS



ELLIOTT C. CUTLER

(D) METHODS OF CLOSURE AND DRESSING OF WOUNDS

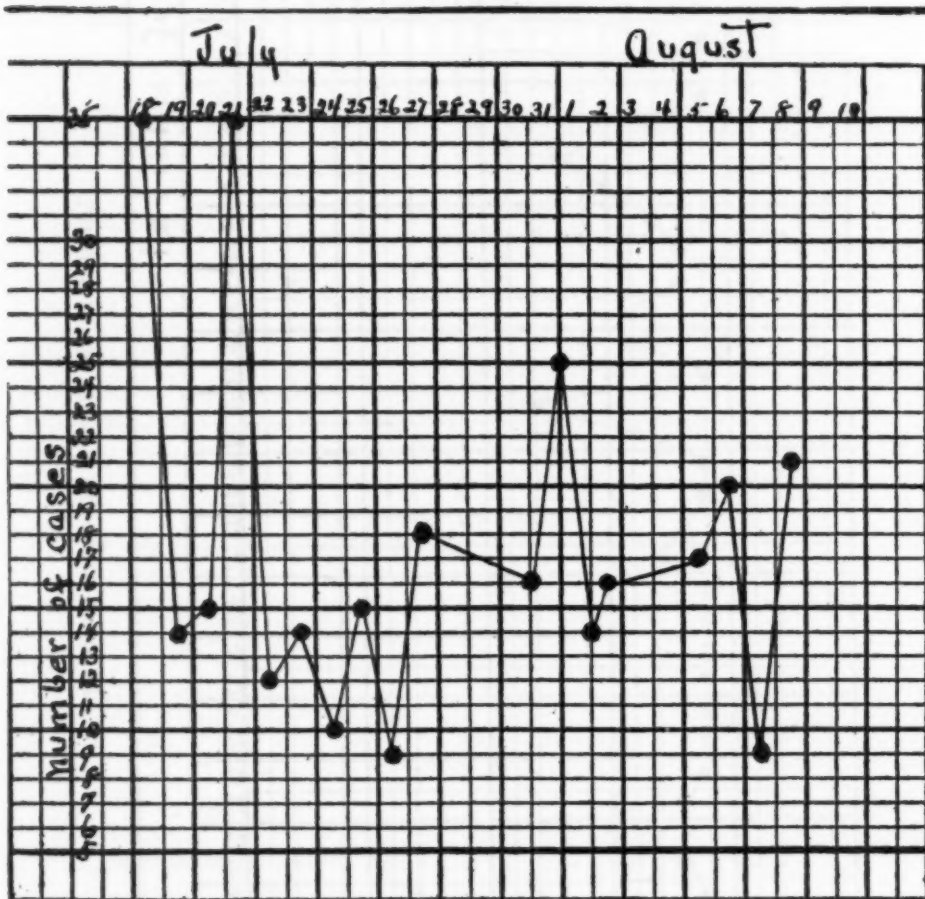
(a) Closure:

1. Primary closure 1 case.
2. Partial closure with small gutta-percha tissue drain.. 9 cases.

(b) No closure:

1. Carrell-Dakin tubes 12 cases.
2. Gauze wet in Carrell-Dakin fluid 161 cases.

(E) DAILY NUMBER OF OPERATIONS



Where the daily number of operations is high, as in the two days of 35 cases, we were on duty 18 hours or more, and there were several cases requiring dressing only.

Total cases in second period 316 cases.

On duty during second period 18 times.

Average number of operations per tour of duty 17.5.

Results.—The data are almost entirely lacking. We were pushed always to the limit of our endurance, and scarcely saw cases more than once, if even that, after they left the table, and many cases left their post-cards behind or lost them on their way down the line.

No operations: (Dressed) 47 cases.

WAR SURGERY UNDER FRONT-LINE CONDITIONS

Amputations.—1. T—Secondary amputation thigh for gas infection.

2. P—Primary amputation thigh for gas infection; fracture of femur and divided femoral artery.

3. K—Primary amputation leg for gas gangrene; three days since injury (German prisoner).

4. McH—Secondary amputation thigh for gas gangrene.

5. Multiple amputations fingers and toes, numerous.

Deaths.—1. McH—Fracture compound skull, penetrating wound to the ventricles.

2. D—Fracture compound comminuted femur and humerus, in shock; cleaned up as much as condition permitted; died in twenty-four hours of gas infection, leg.

3. C—Lesion dividing axillary artery and vein; large foreign body in neck; patient in shock, gas infection; under novocaine foreign body removed and tissues widely opened and subclavian artery tied; died three days later, gas infection.

4. T—Fracture compound comminuted femur and multiple perforation intestines; abdomen opened, closed without repair; died in two hours.

5. C—In shock, shell wound hip and leg; foreign body removed from hip and leg; widely opened; died in twenty-four hours, gas infection.

6. A—Shell wound, chest, entry anteriorly, sucking wound; foreign body in spinal muscles; anterior wound closed; foreign body removed, posterior drainage tubes into chest established at this point; died thirty-six hours, pneumonia.

7. C—Shell wound neck and arm, bulbar paralysis; no operation; died in twenty-four hours of pneumonia.

8. R—Shell wound hip, fracture compound comminuted femur; "débridement," two sutures, Carrel-Dakin tubes, Thomas splint; evacuated under pressure; died some days later at the base hospital. (Report streptococcus septicæmia.)

9. T—Fracture compound skull, penetrating to ventricle, gas infection; foreign body removed at operation and drain inserted—died.

10. N—Fracture compound skull, perforating postparietal region; died meningitis three days.

11. Fracture compound skull, moribund, dressed; died in an hour.

Mortality.—Eleven deaths in 310 cases—3.54 per cent.

General Summary.—The above review is a brief survey of the work done. Its incompleteness makes one uncomfortable, as it may seem an indication of careless work, and yet we think we always attempted to be thorough, careful, conservative, and to treat each case individually and to the best of our ability and experience.

Certain procedures have now become established in our minds and possibly our deductions may be of interest:

Head Cases.—In this field there is little to add to the preceding discussion following the enumeration of the cases done, and nothing at all to

the brilliant contribution on this subject of Lieut. Col. Harvey Cushing, M. C., whose work is widely known and available to all.

Chest Cases.—With experience we have become more and more conservative and now would only operate on cases with injury to the chest for the following conditions: (1) Sucking wounds; (2) the compound chest-diaphragm-abdomen lesions; (3) large and easily available intra-thoracic missiles; (4) non-penetrating wounds or perforating wounds with much bony destruction.

For the other types of injury to the chest we have established the following routine: Rest in bed and the sitting posture, morphia, strapping to limit motion of the afflicted side if advisable, observation. If no indication (sepsis) hastens action, aspiration on the third, fourth or fifth days. This is done irrespective of retained missile or perforating wounds. If infected fluid is found and a foreign body is present, and the general condition worse, the patient is re-X-rayed and then drained under local anæsthesia. Often, if a foreign body is superficially located in the lung it may have formed an abscess and then dropped to the bottom of the pleural cavity, in which case it can be removed. If a foreign body is present and the infective agent not of a violent nature, and the patient's condition good, operation is deferred, and in many cases the infection has been taken care of and the patient recovered without operation.

Chest-diaphragm-abdomen Cases.—These cases, also, do not always require operation. This depends greatly on the size and kind of missile. Small shell fragments and bullets reaching the liver through a lung and diaphragm may allow recovery with a minimum of trouble and without operation. The larger missiles require operation as soon as possible and should be done as near the front line as possible. We believe in opening the chest first, sewing up the diaphragm if the missile has perforated to the liver, and lastly doing the abdominal part of the operation. If the missile is in the liver and infection present, it may be necessary to sew up the diaphragm to the chest wall and drain direct into the liver. Such cases do badly.

Injuries to soft parts and those with fractures are treated alike by wide incision and thorough "débridement." Adequate and correctly applied apparatus is essential in the fracture class of cases, and by experience we have come to be firm believers that primary sutures, except in the following exceptional groups of cases (heads, chests, abdomens, joints and nerves), should not be allowed in evacuation or other front line hospitals.

Injuries to Joints.—We have discussed this class of injury at length following the enumeration of the cases in this report and can only repeat our firm adherence to the principle of mobilization in the treatment of injuries to joints and lay especial emphasis on this method in the case of injuries to the knee-joint.

POST-OPERATIVE SUPPURATIVE PAROTITIS *

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History of Case.—Mrs. D., aged thirty-four years, American, no familial history of neoplastic disease, dyscrasia or tuberculosis. Of the infections during childhood she had measles, chicken-pox, and mumps of both parotids. Three years ago had whooping cough—duration twelve weeks. Menstruated at thirteen, duration eight days, dysmenorrhœa, very irregular to twenty, irregularity represented by intermittent and vicarious nasal bleeding associated with pelvic distress and pain. Married at twenty-one, three para, first instrumental, nursed all children full time; no pelvic or mammary infection.

In October, 1918, had a severe attack of "Flu;" confined to bed five weeks, and never fully recovered from its effects. It was represented by general myalgia, severe headache, chills, fever, bronchitis, general abdominal pain, and much prostration. Associated with the above symptoms the following is significant; pain and stiffness in the lower jaw articulations, dry mouth, swollen brown tongue with no salivary secretion. This continued for two days and was followed with much excretion of sour saliva, the secretion of which lasted eight or nine days. There was not noted any parotid enlargement. Menstruation delayed three months was reestablished in January, the flow lasting five days with associated severe lumbar pain lasting two weeks. Prior to admission to hospital she was vomiting daily all food, and suffered from general abdominal distress with severe pain in right lower quadrant and hip.

Laboratory report on admission to hospital, February 22, 1919, shows the following: Blood, red, 4,500,000; white, 10,600; hæmoglobin, 85 per cent.; fæces negative for blood and parasites; urine, negative, but large amount of bacteria; temperature, pulse and respiration normal during the five days of observation. With rest in bed and continuous enteroclysis, pain subsided and vomiting ceased. Pre-operative diagnosis of pregnancy with an adherent cystic ovary was confirmed by operation February 27, 1919, at St. Vincent's Hospital. Preliminary hypodermic of morphine $\frac{1}{4}$, atropine $\frac{1}{150}$, administered one hour before operation.

Operation.—Under ether anæsthesia on opening the abdomen an ovarian cyst was liberated from its attachment in the right lower abdominal quadrant; further examination proved it to be the left ovary with torsion of its pedicle. Salpingo-oöphorectomy and appendectomy were performed.

The cyst, cocoanut size, had a fairly thick wall enclosing a white, somewhat gelatinous fluid, which was free from bacterial invasion.

* Read before the Academy of Medicine of Toledo and Lucas County, October 17, 1919.

The appendix was involved in the circumscribed peritonitis and presented evidence of chronic inflammation. The body of the uterus was soft and equivalent in size to a six weeks' pregnancy.

The incision was closed with chromic catgut and silkworm gut. Primary union occurred, and at no time was there any further disturbance or reaction from the operative intervention.

On the second day following stiffness of the jaw with swelling of right parotid developed. This gradually increased in size and on the sixth day of involvement of the gland free incision disclosed a beginning suppurative parotitis. White count, 21,400, pus shows clear culture of staphylococcus aureus. The discharge of pus became very profuse on the ninth day and so continued for seven days, gradually subsiding on the thirty-fifth day when healing occurred. Discharged from hospital April 13, 1919, without any salivary fistula. On the eighteenth day of gland infection smear shows but few staphylococci; reds, 3,800,000; whites, 8400; hæmoglobin, 75 per cent.

During the progress of the suppuration the patient's condition was critical. The systemic reaction was characteristic of a high grade of sepsis with meningeal disturbances. Tense and stiff, the muscles of the side of face and head with drooping of eyelid associated with dysphagia continued for six weeks, and at present writing complete restoration of muscle and nerve function has occurred.

October 20, 1919, she was delivered by Dr. W. W. Brand of a nine and one-half pound living male infant. He reports early rupture of membranes forty-six hours preceding labor. That labor was delayed due to atresia of cervix from previous laceration.

The cervix normally dilated, secondary inertia, foetal heart sounds weaker, median forceps delivery, cord wrapped around neck, hemorrhagic circular infarct of placenta three inches in diameter. Present writing mother and child doing well.

Le Dentu¹ says: In suppurative forms of parotitis consecutive to operations early incision is recommended. In fact, the revealing of the suppuration ought not be awaited. Gangrene develops rapidly, which is easily explained by the fact that the gland is constricted and compressed in all parts, and owing to the nature of the infecting microbes. Incise early and widely, avoiding injury and the principal branches of the facial nerve. If the tumefaction appears to be posterior, a long posterior vertical incision is recommended; but two or three large horizontal incisions are to be preferred in practice, a little divergent in front; these suffice when the swelling is principally manifested behind the ascending branch of the lower maxillary. Whatever incision is adopted when the aponeurosis is reached the bistoury ought to be abandoned, a Nelaton cannulated sound substituted, and the gland isolated at depth with this instrument. Generally at first only sanguinous serum flows. The remission is not immediate; it only occurs when the suppuration is free, when the most profound layers are opened to the exterior and the tissues affected by gangrene are eliminated.

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Although in a general way the prognosis of this unfortunate complication is in accordance with the more or less grave condition of the affection, it is certain that the progress can be checked if the principle of early and wide operation which is the basis of the treatment is put into practice.

The microbes obtained from cultures in the author's case were a golden staphylococcus and a streptococcus, the aërobian cultures of which showed a somewhat peculiar aspect.

Morestin² did a colpotomy on a woman aged thirty-three years for a pelvic suppuration. Some days later the patient showed parotitis which became fluctuant. Yellowish pus was expressed from Stenon's duct on pressure. This "expression of the duct" was continued daily and the case ultimately recovered. He reported the case as an example that even in such a severe case operative interference was unnecessary. This paper gave rise to a very extensive discussion in the *Société de chirurgie*.

Delbet thought that the whole gland, not alone Stenon's duct, would be expressed.

Tuffier thought the parotitis not especially due to abdominal operation, but that it could follow other operations, in which *chloroform was the anæsthetic*. It is very rarely that these canalicular cases finish by suppuration and he has only seen two such cases.

Quénu also observed two suppurative cases. One of these was an urgent operation done while the patient was suffering from adenoids, the other patient had a dental affection when operated.

In closing the debate Morestin stated that when incision was necessary it should be below the ear, in the posterior and inferior parts of the gland towards the submaxillary region.

Picqué³ says that in spite of the many researches which had been made to show why an ascending infection can take place in Stenon's duct, yet the last word had not been said on the exact method of the condition.

Picqué pointed out that when suppuration occurs it results with rapidity and habitually within thirty-six hours of the infection; or there may be a total or partial gangrene of the gland combined with suppuration. The microbes met are the streptococcus, the staphylococcus and certain saprogenous associated microbes.

In the true parotitis Picqué has always remarked, contrary to views of others, that nothing from the clinical viewpoint allows any differentiation, at least in the beginning, between gangrenous and suppurative and other types. Incision alone enables diagnosis to be made. The gangrenous types have always appeared fatal to Picqué. He never allows a parotitis to evolve spontaneously. In a total of 7200 operations, he observed only two cases of post-operative parotitis in cases which were infected (acute appendicitis and extra-uterine pregnancy with infection). In both cases the affection was cured by early operation.

Buscarlet⁴ illustrates a case and thinks that very severe post-operative parotites are only local manifestations of a general infection.

Lenoir⁵ says: If exploration reveals an appreciable fluctuating collection, or if anything should suggest the thought of a gangrenous evolution (and this is sometimes produced very rapidly in the case of cachectic patients) it is necessary to incise without delay. Unfortunately there are no symptoms which enable us to foresee the beginning of this complication; but it will be well to keep in mind this possible evolution of such post-operative parotitis. Picqué has declared that he never abandons this complication to a spontaneous evolution.

Gary⁶ says: Very often post-operative parotitis evolves towards suppuration. Suppuration is not always easy to recognize. Palpation gives an obscure feeling; a daily minute examination of the outlet of Stenon's duct is necessary, whence issues the droplet of pus which fixes the diagnosis.

In fortunate cases evacuation will be by the natural routes. But it is not unusual to see the fibrous resistant casing of the gland rupture through the teguments, sometimes creating a persisting salivary fistula; or even the more formidable eventuality, *i.e.*, abnormal passages from the extern auriculation, or which fuse towards the supra-clavicular region through the sheath of the sterno-mastoid, or even in the mediastinum following the sheath of the vessels.

Retropharyngeal abscesses have been formed in the aponeurosis of the parotid site.

Suppuration may end in gangrene. The violet skin becomes sphacelous, allowing multiple gas bullæ to escape as well as sanious fluid of infected odor. Phlebitis and thromboses may result. The vessels may ulcerate, cause heavy hemorrhages, necessitating ligature of the extern carotid, or leading to death. A case reported by Richel necessitated ligature. In a case reported by Gilette death resulted.

The gangrenous form which is much less frequent in the post-operative parotitis than in the parotitis of severe infections is almost always fatal. The patient, in stupor and adynamia, succumbs to pyohæmia.

Wagner⁷ states that post-operative parotitis ends in death in 30 per cent. of the cases. Legueu, who lost a patient from parotitis, in spite of large and early operation, protested in 1907 against the tendency to consider this complication as benignant, and declares that he is always very anxious when he sees it develop.

In cases when the treatment is by incision the surgeon must not count upon finding fluctuation. Owing to the very close texture of the parotid the pus infiltrates into the glandular tissues, creates little multiple pockets and only exceptionally collects. A single incision sometimes is sufficient, but often multiple incisions are necessary. By making the incision as retrograde as possible and towards the sterno-mastoid, the scar will be less visible and injury to the facial nerve will be avoided. After section of the skin the bistoury should be replaced by the cannulated sound.

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Bachrach⁸ describes a case of suppurative parotitis after a jejunostomy. This patient died from anæmia, and autopsy showed the local wound absolutely uninfected. There was hence no question of a spreading of infection through the lymph or blood. Diplococci were obtained from the pus of the parotid abscess which was incised.

The route of infection must be oral. It is due to the hunger treatment and rectal feeding and disturbance in the secreting glandular apparatus of the mouth.

Hanau⁹ and Pilliet¹⁰ first suggested in 1889 that parotitis could occur as secondary infection of Stenon's duct by mouth organisms. The inflammatory process begins in the centre of each lobule and spreads later to its periphery and perilobular tissues and blood-vessels. It is an ascending infection.

Girode¹¹ found cultures from the parotid infected gland, Stenon's ducts, and the oral cavity to be identical. In embolic parotitis due to pyæmia the microbes are identical with those of the primary disease.

Clause and Duplay¹² showed that infection of the parotid occurs in abnormally predisposing conditions, one of which is that the general vitality is depressed by hunger or other methods, or when the normal parotid secretion is altered.

Josephson¹³ in analyzing literature of post-operative parotitis comments on the undoubted connection between the salivary and the genital glands, at least in the line of inhibiting secretion. This renders the inhibited gland less resistant. The sudden removal of this functioning ovarian tissue may upset the balance in the internal secretions, the salivary glands suffering particularly and parotitis follows.

Frank¹⁴ in reporting two cases following appendicitis, one fatal, reviews the existing theories and concludes that its origin is due to an ascending infection of Stenon's duct; advises prophylaxis and early incision.

Blair¹⁵ discusses two theories: (1) metastatic, (2) ascending infection of the excretory duct, neither of which is above dispute. He points out the similarity of infections of salivary and biliary ducts and that stone irritation and obstruction are productive of intermittent enlargements of the glands, and that subacute or chronic inflammation without stone is not common. He reports seven cases, two mild, which recovered following incision and drainage. Five were severe infections, three recovered, and two died of general sepsis.

Collins¹⁶ reports eight cases of post-operative parotitis with four deaths and concludes that it is more apt to occur after abdominal operation, its development is favored by dry mouth, the infection ascends through Stenon's duct, advocates prophylactic oral asepsis, hypodermoclysis, and lemon candy to excite the salivary secretions and after the third or fourth day by free incision.

Deaver¹⁷ classifies post-operative parotitis into three groups: metastatic, occurring only in pyæmic condition; ascending parotitis, due to

ascending infection via the excretory ducts; and traumatic, the result either of direct pressure on the parotid gland or the forcible manipulation of the jaw by the anæsthetist during operation.

Manton,¹⁸ commenting on a fatal case of suppurative parotitis following induced abortion, says: Two sources of gland involvement, first general or metastatic, second, local, either through the lymphatic glands or ascending infection through Stenon's duct. There were no pelvic symptoms developed before the nineteenth day when general infection was well established; but the patient's mouth was foul from the beginning and he concludes the gland involvement was of oral rather than of pelvic origin.

Fortunately post-operative suppurative parotitis is a rarity. But few cases or none are allotted in the life work of the surgeon as an individual. Collectively there have been many reported cases.

While my remarks are directed to the consideration of suppuration of gland, much can be applied to the phenomena of the ordinary infective parotitis. The gland is subject to the mild types of inflammation in varying degree to the more severe pathology of suppuration and gangrene. In presenting the following abstracts and reports of cases, attention is directed to the diversity of opinions regarding this subject. It is the purpose of this paper, by comparison of the various theories, a critical review of case reports, and my own personal experience, to enunciate certain principles in the hope to dispel many of the debatable points and to bring the subject in somewhat of a logical state.

During a surgical service of thirty years the writer has had under observation some twenty cases of infective parotitis, post-operative. One fatal suppurative case occurring during the fifth day of pneumonia was seen in consultation fifteen years ago. The abscess was not drained, the patient dying a few hours later. In my experience the type of operation itself had but little direct influence on the parotitis, for it followed in one case from amputation of hip, in another from herniotomy. Neither from the anæsthesia, for it developed in the earlier days when chloroform was used exclusively, also during ether anæsthesia, also nitrous oxide and oxygen anæsthesia, and also local anæsthesia.

Preliminary hypodermics administered one hour before operation, morphine when chloroform was administered, morphine and atropine for ether, H.M.C. for nitrous oxide and oxygen, and morphine for local anæsthesia; these facts are not impressive in their relation to parotitis as causative factors.

The season of the year has made no appreciable difference in the infection, occurring at any time with equal severity.

Bertelsen¹⁹ reports from Umanak, Greenland, that epidemic parotitis was introduced in 1913; that over one-half of the population was affected and that fifty per cent. of the nursing women had mastitis. That there was one suppurative mastitis and one suppurative parotitis.

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Inquiries among industrial surgeons concerning suppurative parotitis following injuries of the soft structures of the face or fractures of the maxillaries elicited a negative response. Even in the presence of extensive suppuration and foul mouths infective parotitis did not develop. The prize fighter deletes his opponent with a mandibular blow on the masseteric tuberosity which disturbs the circulatory equilibrium of the semi-circular canal and at the impact the parotid must receive some injury. The results of such injuries have been negligible as to infective parotitis. A consideration of the lymph channels of the face reveals the important fact that the only afferent chain to the parotid lymph-nodes drains the temporal region, while the oral and pharyngeal glands empty into the deep cervical. The anterior auricular nodes are small, three or four in number. Their location is superficial, anterior to the ear, upon the parotid gland, and they drain the temporal region, their efferents passing either to the superficial, cervical or the submaxillary nodes. The parotid nodes are imbedded in the substance of the parotid gland and receive lymph from the gland and also from the eyelids and the external ear. Their afferents pass to the superficial cervical or superior deep cervical nodes. The deep facial nodes are situated upon the buccinator muscle and on the lateral wall of the pharynx. They drain the deep lymph vessels of the face (orbit, nasal cavity, palate, etc.) and come into relation with the superior deep cervical nodes, there being no distinct line of separation between the two groups.

These anatomical facts definitely eliminate the transmission of infection to the parotid through the lymph channels of the mouth, unless we consider the question of retrograde embolism, which is hardly feasible, as the clinical signs are lacking.

The pyogenic micrococci that are found in suppurative parotitis are the staphylococcus, streptococcus, and pneumococcus. The characteristic attribute of the staphylococcus which is most frequently found in suppurative parotitis is that having gained an entrance into susceptible tissue it at first produces a local infection or spreads to surrounding structures from which general distribution through the blood stream occurs. Evidence is lacking that there is a primary circumscribed inflammatory reaction of buccal tissues. Notations show the orifice of Stenon's duct but slightly involved, though pus exudes in quantities. The streptococcus grows on mucous surfaces and penetrates into the tissues, producing inflammation, more rarely concentrated in abscess formation. Invading the lymphatics, they are carried into the blood stream producing general bacteriæmia, or attacking the blood-vessels, producing infected thrombi, from which they are continually shed into the circulating blood. During the course of a pneumonia, especially of the more severe types, the pneumococcus may gain access to the general blood stream and produce pneumococcus septicæmia. It is during the acme of this bacteriæmia that parotid suppuration ensues.

— Fenwick,²⁰ in an article entitled "The Prevention of Parotitis During Rectal Feeding," believes the infection ascends Stenon's duct. He advises the use of a rubber teat for hours to stimulate the flow of saliva. This procedure with rectal alimentation prevented parotitis in more than three hundred cases of hæmatemesis.

— Rolleston and Oliver²¹ in the medical treatment of one thousand cases of gastric ulcer conclude that secondary parotitis may complicate gastric ulcer by oral starvation; it occurs ten and one-half times more frequently than in cases allowed fluid by mouth; that it is an outcome of the dry condition of the mouth; that mouth washes are preventive; that suppuration occurs in about one-fourth of the cases.

Moreau²² reports two cases of suppuration of parotid following severe malarial fever. He emphasizes the necessity of oral asepsis supplying the organism with water, and concludes that dehydration favors ascending infection in the mouth.

At this juncture it would be well to consider the general character of bacterial infections.

MacCallum²³ writes: "Virulent bacteria in a person whose resistance is low may, however, grow rapidly and be quickly transported to other parts of the body by the lymphatic channels, or even in some cases by the blood stream. If an intestinal loop is ruptured, pouring great quantities of infected material into the peritoneum, the bacteria are taken into the lymphatics of the diaphragm, and hence through the mediastinal lymph channels to the retro-sternal lymph-glands with the greatest celerity, and after a very few minutes may be found in the circulating blood.

Bacteria alone introduced into the tissues or body cavities are relatively easily killed. If, however, foreign bodies or dead tissue are present there, to afford a shelter against the disinfecting action of the tissue juices until multiplication to great numbers has occurred, the bacteria can more readily gain a dominating position. Bacteria in the uterine cavity in the puerperal state may be practically harmless were it not for the protected culture-medium offered by remains of detached and dead placenta, in which they reinforce themselves by growth until they can victoriously invade the uterine wall."

The effects of the late epidemic of "Flu" in the following case are illustrative and significant. In a personal communication Mannhardt reports a female, aged thirteen, affected with the respiratory type lasting five days, infective parotitis ensued for five days. During the progress double ovarities developed; this was followed in a few days by severe epigastric pain and vomiting with jaundice. Palpation over pancreatic area elicited much acute pain and tenderness. Convalescence was protracted. The following month menstruation was established, since which time she has been regular, duration five days, no associated pain. Preceding the menses one week she suffers with jaundice and an eczema of palms of both

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hands. Both disappear when menstruation ceases. These phenomena have continued for past seven months.

From the foregoing we are forced to conclude that our theories and views of the origin of the involvement of the parotid are erroneous, for they cannot be sustained by well proven facts of bacteriology, anatomy, or pathology.

In seeking for a logical solution of parotitis let us consider briefly the physiology and bio-chemistry of the gland.

Macleod:²⁴ "Control through the nervous system is most marked—indeed, it may be the only means of control—in glands which have to produce their secretion promptly, whereas hormone control predominates in those in which prompt changes in secretory activity are not required. Thus, nervous control alone is present in the salivary glands, whereas hormone control is predominant in the pancreas, intestinal glands and liver."

The parotid nerves are derived (*a*) from the auriculo-temporal, (*b*) from the sympathetic on the exterior carotid. The fibres of the sympathetic are vaso-constrictor. Those of the auriculo-temporal convey to the gland secretory fibres from the glosso-pharyngeal. In other words the cerebral autonomic, and the sympathetic autonomic. These two nerve supplies have usually an opposite influence on the secretory activity of the glands, and very frequently also on the vascular changes that accompany secretory activity. That there are really two kinds of secretory fibres, called secretory and trophic, the former having to do with the secretion of water and inorganic salts, and the latter with the secretion of organic matter, *i.e.*, with the extrusion of the zymogen granules.

When secretion occurs, it is caused by influences acting on a nerve centre or centres in the medulla oblongata, the exact location of which for the different glands has been worked out in recent years by Miller. The impulses acting on these centres may be transmitted along different nerves coming from the mucous membrane of the mouth, nares, etc., or by impulses which we may call psychic, transmitted from the higher nerve centres. The reflex secretions caused by impulses travelling by the afferent nerve from the mouth, etc., have been called unconditioned, and those from the higher nerve centres, conditioned.

The investigations that have been made on the conditions of psychic secretion of saliva are still more interesting and important. Their importance depends not so much on the information they give us concerning the secretion of saliva as such, as on the methods they afford us for investigating the various conditions that affect the psychic processes associated with the taking of food. Further investigations show there must be an inhibition of psychic stimulation of the salivary centres by other nerve centres. It is of great interest that this inhibition may itself be inhibited by various forms of stimulation of the nervous system.

It is possible when anything excites the cell to secretory activity, such

as a nerve impulse, it does so by causing a change in the permeability of the lumen border of the cell. This change in permeability may be dependent upon alterations in surface tension brought about by the migration of electrolytes to the border. That such a migration of electrolytes does actually occur has been demonstrated by MacCallum.

Other observers believe that when the gland becomes more active, the molecules present in the cell become broken down into smaller molecules and so raise the osmotic pressure of the cell content, with the result that water is attracted from the blood and is then transferred to the lumen.

Other changes noted during activity entail a considerable expenditure of energy. This is indicated by the fact that considerably larger quantities of oxygen are taken up by the gland when it is in an active state than when at rest. Thus, oxygen consumption of the resting gland may be increased five times during active secretion. On account of this increased oxygen consumption it is not surprising that it should be found that the secretory activity of the cell is greatly impaired by a deficiency in oxygen.

We have seen that suppurative parotitis does not belong exclusively to the realm of surgery from operations performed on other organs of the body; that it occurs with startling frequency in many of the medical diseases.

We are familiar with the fact that pyogenic microorganisms that produce septic parotitis have a natural habitat in the human system; that they are innocuous just as long as the individual resistance of tissue and blood plasma confer an immunity or hold them in check; that they are called into activity by any insult or injury to the tissues; that they are disseminated rapidly through the lymph channels into the blood stream or directly into the circulation producing bacteriæmia, from which no organ, if susceptible, escapes their virulence; that cachexia and malnutrition from whatever source are predisposing factors by lessening resistance.

We are further cognizant of the fact that the salivary glands are dependent upon nerve stimuli for their secretion; that a lowered nerve tone from disease or inhibition of the nerve stimuli from surgical shock may so impair the salivary secretion that partial or complete stasis results. It is at this stage that circulating bacteria, having a predilection for gland tissue, produce their lethal results.

From the foregoing facts and case reports and clinical observations, I am convinced that the former theories of the origin of parotid involvement should be expunged.

CONCLUSION

1. That septic parotitis is of hæmatogenous origin.
2. That cachexia and malnutrition by lowering resistance are predisposing factors.
3. That susceptibility of gland is favored by stasis.
4. That secretion of gland is under the influence of nerve stimuli and

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that the incidence of post-operative parotid involvement is neurologically dependent upon surgical shock or inhibition of the secretory and trophic fibres from higher psychic centres.

5. That the gland must be susceptible to pyogenic microorganisms and when affected bacteraemia exists in all cases.

6. That early incision and drainage are indicated.

7. That the surgical technic advised by Lilienthal and Blair should be employed.

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DRAINAGE IN APPENDICITIS *

A REVIEW OF CASES OF ACUTE APPENDICITIS REQUIRING DRAINAGE AT THE PRESBYTERIAN
HOSPITAL, NEW YORK, N. Y., 1915-1918

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FROM January 1, 1915, to December 1, 1918, 622 cases of acute appendicitis were admitted to the Presbyterian Hospital, New York City. This number includes cases in which the inflammatory process was fairly limited to the appendix itself, and recorded as acute appendicitis; and cases in which the peritoneal cavity presented evidence of varying degrees of contamination or infection from organisms passing through the appendix wall. The latter have been somewhat arbitrarily, but for the most part satisfactorily classified as follows:

1. Acute appendicitis with acute local peritonitis.
2. Acute appendicitis with peritoneal abscess, subcæcal, mesiocæcal, laterocæcal, etc.
3. Acute appendicitis with extraperitoneal abscess, retrocolic or retro-cæcal.
4. Acute appendicitis with acute diffuse peritonitis.
5. Acute appendicitis with progressive fibrino-purulent peritonitis.

Definition of diagnostic terms:

1. *Acute Appendicitis*.—The pathological changes are limited to the appendix, meso-appendix, and in some cases the cæcal wall in the immediate

* NOTE: As a result of the experimental study of certain chlorine antiseptics in localized peritoneal infections in dogs,¹ the antiseptic post-operative treatment of cases of acute appendicitis requiring drainage was undertaken first in February, 1918, as a routine in the wards of the Surgical Service at the Presbyterian Hospital, New York City. Aside from the eighteen cases which have been treated by the writer, the method has been employed by others in thirteen cases of appendicitis and in a number of intra-abdominal drainage tracts accompanying other conditions.² That a fair criterion might be established by which judgment could be passed upon the results attained by the antiseptic method, an analysis of 263 similar cases occurring during the past four years has been made. This period corresponds with that of the follow-up system of the hospital, and is, therefore, especially satisfactory in determining the incidence of certain sequelæ and late secondary procedures.

¹ A Study of the Intra-abdominal Use of Dakin's Fluid and Dichloramine-T Solutions, with Special Reference to Local Peritoneal Infections. *Jour. Exp. Med.*

² The Clinical Application of the Carrel-Dakin Method to Cases of Acute Appendicitis Requiring Drainage. *Surg., Gynec. and Obst.*

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vicinity of the base of the appendix. The serosa of the appendix must show acute inflammatory change, *i.e.*, redness. Fibrin deposit usually is present in some degree. Gangrenous areas of the wall or extensive gangrene of the appendix may exist. A very recent perforation may be present. Free peritoneal exudate, clear, cloudy, odorless or with faint odor may be found.

2. *Acute Appendicitis with Acute Local Peritonitis.*—Lesions of the appendix present are those of acute appendicitis with a larger percentage showing gangrene and perforation of the wall. Acute inflammatory changes are present in the coils of intestine adjacent to the appendix; *i.e.*, redness, changes in lustre, and in many instances fibrinous deposits; omentum shows various stages of involvement. Exudate is present as in the former condition, or there may be a definite odor to the pus without localization. The latter often indicates a transitional stage between acute local peritonitis and peritoneal abscess.

3. *Acute Appendicitis with Peritoneal Abscess.*—The appendix usually presents signs of advanced inflammatory changes. One or more localized collections of definite pus must be present. In most instances this is foul smelling, but may be odorless. The pocket of pus may be walled off by organized adhesions, but often minimal delicate adhesions of fibrin alone are found. Outlying localized or diffuse peritonitis with free exudate may occur, and in such cases the additional diagnosis is given and cross-referenced.

4. *Acute Appendicitis with Extraperitoneal Abscess.*—Includes cases in which the abscess from the appendix originates in tissues without the general peritoneal cavity and involves the extraperitoneal areolar connective tissues.

5. *Acute Appendicitis with Acute Diffuse Peritonitis.*—Any of the above lesions of the appendix may be present. Serosa of the intestinal coils as far as exploration is carried shows uniform inflammatory changes: redness with diminution of lustre or deposits of fibrin or fibrino-purulent exudate. Distention of the intestine is usually found. Exudate is free, clear, cloudy, odorless or odoriferous.

6. *Acute Appendicitis with Progressive Fibrino-purulent Peritonitis.*—This term is restricted to the comparatively rare condition in which the intestinal coils as far as exploration is carried are found with surfaces glued together by organized fibrino-purulent exudate. Bleeding occurs when the attempt is made to separate the coils. Numerous pockets of pus are present between the adherent intestines.

These terms represent stages in the progress of infection of varying degrees of virulence in individuals of varying resistance discovered at operation at varying periods of time from the onset of the attack.

The following table gives the totals of the cases of the various types during the years mentioned. The cases of peritoneal abscess with accom-

panying local peritonitis are included with the first condition; those of peritoneal abscess with acute diffuse peritonitis are given in the column of the latter condition.

TABLE I

Year	Acute appendicitis	Acute appendicitis with acute local peritonitis	Acute appendicitis with abscess (peritoneal and extraperitoneal)	Acute appendicitis with acute diffuse peritonitis	Acute appendicitis with progressive fibrino-purulent peritonitis	Yearly total
1915.....	93	26	57	11	0	187
1916.....	74	30	41	11	0	156
1917.....	62	30	40	7	1	140
1918.....	79	22	34	4	0	139
To December 1						
						622

Five hundred and eighty-nine of these 622 cases were operated upon, and with few exceptions, operation followed immediately upon the establishment of the diagnosis, regardless of the stage of infection. The appendix was removed, if at all accessible, and the wound either entirely closed, or mural or intra-abdominal drainage instituted.

The operator's conception of the infective status of the case determines his procedure in regard to peritoneal drainage, or closure of the abdominal wall. It is probable that in most cases of acute appendicitis a more or less active contamination of the peritoneum is in progress as early as twelve hours.³ The great reserve power of visceral and parietal peritoneum and omentum in combating infection is called into play. Through the agency of their blood-vessels and lymphatics, these structures respond to the bacterial insult, and during the interval preceding operation may afford adequate protection of the peritoneal cavity at large. The fact that many cases survive one or more attacks of acute appendicitis without operative interference testifies to the very considerable power of the peritoneum in dealing with infections. This knowledge gives the surgeon confidence in closing the peritoneum after removal of its infecting focus, in dealing with the lesions of the first type (acute appendicitis) and early or mild cases of the second type (acute appendicitis with acute local peritonitis). In many instances, however, the wall of the appendix early becomes badly compromised and the bacterial invasion thrown upon the peritoneum is so great that its defensive mechanism is strained or overtaxed. An intense, local peritonitis usually appears in response to the injury, and a peritoneal exudate rich in bactericidal elements is thrown out. With a heavy bacterial contamination, phagocytosis can-

³E. Moschcowitz: The Pathological Diagnosis of Diseases of the Appendix Based on the Study of 1500 Specimens. *ANNALS OF SURGERY*, June, 1916.

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not keep pace with bacterial growth, and the exudate rapidly becomes foul and purulent. It is this transitional stage between contamination and progressive infection, between a strained and an overtaxed peritoneum that constitutes the border line between those cases that may be closed safely and those in which intraperitoneal drainage seems a necessity. If the peritoneal cavity be closed, one must feel reasonably certain that the residual infection will be taken care of without even the formation of a localized abscess. The infective status of the case must be determined from a consideration of the condition of visceral and parietal peritoneum, the omentum and the character of the exudate present. Briefly, if the peritoneum over a considerable area shows a definite disappearance of gloss or is covered by fibrino-purulent exudate, and the free exudate is odoriferous, indicating a decline in its bactericidal properties, most surgeons decide upon intraperitoneal drainage. The condition of the appendix, if removable, is of secondary importance.

If infection has progressed to the stage of intraperitoneal abscess, drainage becomes almost imperative. There was but one exception to this rule in the cases reviewed. In this instance, empyema of the appendix was present and there was a small amount of odorless, creamy pus about the appendix; the visceral peritoneum did not appear compromised. Following removal of the appendix and evacuation of the abscess, the peritoneum was closed. The procedure was followed by a favorable outcome. Culture of the pus proved sterile. While occasionally it is possible to differentiate a "cold" abscess of this type, and despite the probability that outlying pus pockets in advanced infections are occasionally taken care of by the peritoneum, it would seem more the part of wisdom to make provision in these cases for escape of any necrotic tissue that may line the cavity.

The advisability of drainage in acute appendicitis with diffuse peritonitis is often questioned. The picture indicates that the mass of infection is great or the resistance of the individual below par. Whether drainage from the general peritoneal cavity continues for an hour after operation or for one or two days,⁴ it would seem advisable to afford the peritoneum whatever advantage drainage may give. In some instances adhesions about the drainage tubes probably form as rapidly as fibrin can be deposited between the surrounding coils and escape of infective exudate is slight; on the other hand, it is possible that there may be but little attempt at adhesion formation and the fluid from a considerable part of the cavity may find exit for a more prolonged period. While it is doubtful if conclusions of much value may be drawn from infections in dogs, it was interesting to observe the entire absence of adhesions in one case of diffuse peritonitis autopsied twenty-four hours after drainage.⁵

⁴ Murphy, J. B.: Quoted by F. Matthews, Johnson's "Operative Therapeutics."

Finally, in the cases of acute appendicitis with progressive fibrino-purulent peritonitis, if operation is attempted, the advisability of drainage cannot be questioned.

Closure of the peritoneum and drainage of the tissues of the abdominal wall is a practice which arose as a result of the observation that in certain cases of acute appendicitis with a degree of localized infection that might be safely controlled by the peritoneum, the contamination of the wound during operation led to its secondary infection. In other words, it is a recognition of the lesser ability of the structures of the abdominal wall to deal with the infecting organisms.

The accompanying Table II represents dispositions of the cases of Table I, together with secondary infections occurring in the first two groups, duration of hospital stay, and mortality.

Conclusions as to duration of suppuration, time of hospital stay, secondary procedure, condition of wound on discharge, subsequent ventral hernia, etc., have been prepared from a tabulation of the 263 cases. There are certain reasons why deductions from the total number of drainage cases should prove more fair and valuable than those drawn from arbitrary groups. A very large percentage of the cases in which intra-peritoneal drainage was used were those of advanced infection. Many of the 71 cases classed as acute localized peritonitis had free foul pus and their subsequent course in certain instances seemed to be that of a diffuse peritonitis; 178 had definite abscess formation; 33 cases were classed as acute appendicitis with acute diffuse peritonitis, some of these having one or more subsequent abscesses. The inclusion of a comparatively few minor infections in a group of 263 cases does not affect percentages and places the error to the credit side of the cases treated by simple drainage when we compare results with cases treated by the antiseptic method. A composite view of the disease in its severer form is what one wishes to obtain as a criterion in determining the value of any method of treatment. While the impression made by the pathology of the case rarely deceives the surgeon as to advisability of drainage, a careful reading of the data of operation and post-operative course often leads one to view with suspicion the diagnosis accorded the case. Table II is in consonance with the corrected hospital records. The review of these case histories brought to light numerous errors, in the correction of which the cooperation of several members of the staff was enlisted. Despite the fact that a very considerable amount of time and care was given to this work I do not feel that even now the placing of cases in all instances is free of error or could be rendered so from the recorded data. Reference to the table of case groups is of value in indicating the comparative uniformity of infections received from year to year.

* Rulison: A Study of the Intra-abdominal Use, etc., *ibid.*

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TABLE II

Year																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
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* Average all cases 19.1 days (Dakin except).

REVIEW OF 263 CASES OF ACUTE APPENDICITIS WITH INTRAPERITONEAL DRAINAGE

Type of Incision.—This is of interest only as indicating accuracy of diagnosis and from the standpoint of hernia. The intermuscular incision of McBurney was used in 176 cases (67 per cent.); the intermuscular incision with extension into the right rectus sheath (Weir) in 43 cases (17 per cent.); the right rectus incision through the muscle in 30 cases (11 per cent.). The incision through anterior rectus sheath with retraction of rectus muscle towards mid-line (Kammerer) was employed in 2 cases and the transverse incision (Rockey) in 3 cases. A median vertical incision indicating either advanced peritoneal infection or doubt as to diagnosis was used in 9 cases (3 per cent.). An additional stab wound in right flank for dependent drainage of the lumbar gutter was made in 10 cases (3.8 per cent.). Ventral hernia was noted in 21 cases in which the intermuscular incision was used, 6 cases in which the Weir incision was used, and 6 in which the right rectus incision was used. Bulging at the site of scar, not classified as hernia, was present in 18 of the intermuscular cases, 7 of the Weir extension cases, 3 of the rectus and one median. In percentages weak wall or hernia occurred in 22.3 per cent. of intermuscular, 29 per cent. of rectus, and 30 per cent. of Weir extension. There were several instances in which weak wall at site of intermuscular scar with definite bulge improved during the interval of follow-up visits and eventually disappeared. This has been attributed to muscular hypertrophy occurring as the patient resumes active exercise. The larger percentage of hernia in rectus incisions was expected, owing to the pull exerted on the wound by the lateral abdominal muscles. Incision into the rectus sheath also appears to add somewhat to the possibility of hernia.

Pathological Findings at Operation.—Reference to Table II indicates in general the broader phases of pathology presented.

Condition of Appendix.—Not located in 13 cases (4.2 per cent.); apparently not more involved than regional peritoneum, but classed as acute appendicitis in 1 case; acutely inflamed, but not gangrenous in 56 cases (21 per cent.); gangrenous in 185 cases (70 per cent.); perforated in 88 cases (34 per cent.); thrombosis of vessels of meso-appendix in 10 cases (3.8 per cent.); abscess of meso-appendix, 3 cases.

Exudate.—Clear, free fluid was noted in 10 cases, cloudy free fluid without odor in 63 cases, free foul exudate in 14 cases, pus not localized in 32 cases. In 137 of the 178 cases with abscess the size of the collection was recorded; of these, 65 were collections of more than two ounces; 72, collections of less than two ounces. Multiple pus pockets were present in 9 cases (3.4 per cent.). Odorless pus was noted in 22 instances, foul pus in 130 instances, or nearly 50 per cent. of the total group.

The various locations of the appendix and pus collections are of interest and importance from several viewpoints. In several of the cases

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with acute diffuse peritonitis, rapidly terminating fatally, the appendix has been found lying free on the pelvic brim or in a mesial direction. On the other hand, with very few exceptions, the retro-, latero- and sub-cæcal positions have given rise to a more localized peritonitis and have favored circumscribed abscess formation. Our records of the past four years are in consonance with the opinion, often expressed, that the rapidity of the development of symptoms and the clinical course of the case is dependent largely upon the position of the appendix.

The location of the pus collection is of particular interest in considering drainage procedures and will be referred to under that heading. The following is a summary of the various abscesses recorded in the 263 cases reviewed.

Extraperitoneal abscesses: Laterocolic, 4; retrocæcal, 5; retrocolic, 3.

Peritoneal abscesses: Laterocolic, 18; mesiocolic, 15; pelvic, 54; pro-cæcal, 10; retrocæcal, 41; subcæcal, 21; subhepatic, 3; right hypochondriac, 1.

The yearly totals of these various appendix and abscess locations show a very marked close uniformity.

Cedema of the properitoneal tissues was noted many times, but definite cellulitis of abdominal wall tissues was recorded in but 7 cases. This is strong evidence of the view that prior to operation the abdominal wall may be said to be free of gross infection.

Bacteriology.—Cultures of exudate or pus were taken in 189 of the cases, at the time of operation. These, for the most part, were aërobic only. Thirty cultures (16.3 per cent.) proved sterile. In nearly every instance these were exudate cultures obtained in the acute appendicitis or acute appendicitis with acute local peritonitis groups. In only two instances were organisms present on smear which failed to grow. The following is a list of organisms recovered either alone or symbiotically.

B. Coli Communis, 114 of 116 positive cultures (71 per cent.) *B. Coli Communis*, 3.

Streptococcus (not further differentiated), 75 times—47 per cent.

Streptococcus hæmolyticus, 5 times. *Streptococcus non-hæmolyticus*, 17 times.

Some form of streptococcus was recovered in 97 cases, or 60 per cent.

Staphylococcus, 18 times—11.3 per cent.

Of the rarer forms recovered: *Bac. Friedlander*, 4; *Pyocyaneus*, 4; *B. Proteus*, 4; *B. Lactis Aërogenes*, 5; *B. Fecalis Alkaligenes*, 3; *B. Mucosus Capsulatus*, 3; *Pneumococcus*, 2; *Micrococcus Tetrages*, 1; *B. Paratyphosus*, 2; *B. Diphtheriæ*, 1; Gram-negative bacilli not further differentiated were reported in 10 cases; Gram-positive bacilli in 6 cases; Gram-positive coccus in 5 cases.

The association of some form of streptococcus with the colon bacillus was by far the most common (44 cases).

The association of streptococcus with *B. Pyocyaneus*, *B. Friedlander*, *B. Fecalis Alkaligenes* was observed in several instances.

Pure cultures of *B. Coli Communis* were reported in 42 cases; pure cultures of some form of streptococcus in 13 cases. Pure cultures of staphylococcus aureus and albus and *B. Coli Communis* were also reported.

The type of organisms recovered at operation does not seem to furnish any information of prognostic value. The various symbioses noted above were found alike in mild and severe grades of peritoneal infections. Cultures were taken in 6 of the 8 fatal cases with acute diffuse peritonitis with the following results:

History No. 32100; death two hours after operation. Streptococcus.

History No. 35951; death twelve hours after operation. Gram-negative diplococcus; Gram-negative bacillus; staphylococcus.

History No. 31879; death sixteen hours after operation. *Bac. Coli Communis*; streptococcus.

History No. 35468; death four days after operation. *Bac. Paratyphosus*.

History No. 21685; death seven days after operation. *Bac. Pyocyaneus*; *Bac. Coli Communis*, *B. Proteus*.

History No. 31294; death seventy-four days after operation. Streptococcus non-haemolyticus.

Cultures were made in 16 of the 22 recovered cases of the same group. Six pure cultures of *B. Coli Communis* and five cultures of *Bac. Coli Communis* with some form of streptococcus were reported. In the remaining 5 cases there was a pure culture of streptococcus; *Bac. Coli Communis* with *B. Fecalis Alkaligenes*; *Bac. Coli Communis* with a staphylococcus (2 cases); *B. Coli Communis* with a Gram-positive diplococcus.

Methods of Drainage and Post-operative Care of Wounds.—There is probably no common surgical condition that is more variously treated than the one under consideration. The cases reviewed were those of fifteen operators, and the manner in which the cases were handled was varied, both from the standpoint of the different operators, and also in regard to similar cases of the same operator. The inference that may be drawn is that, as in any condition in which the therapeutic measures employed are legion, no one is entirely satisfactory. Each operator's procedure is necessarily based upon his surgical training and experience. The tendency to standardization of treatment was especially noticeable in reading the cases of the operators of longer surgical experience. The cases were tabulated in such a manner that the results of operators using different methods might be determined. For example, Surgeon A. invariably placed a cigarette drain to pelvis and a gauze drain to stump of appendix which was tied off. His post-operative wound cure was an early removal of the gauze drain and a late removal of the cigarette drain with only occasional irrigation of drainage tract. Surgeon B. invariably placed a single large calibre, thin-walled, soft rubber drainage tube to pelvis and on the second or third day substituted a soft rubber catheter through which the tract was irrigated daily by salt solution or boric solution. Each operator had about the same number (28 and 30) of cases,

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extending over the past four years, and their cases compared closely in type. A comparison of their results will be taken up later.

In reviewing the cases of the men of shorter experience, changes in procedure from case to case was particularly noticeable. Surgeon C., for example, was having very good results with rubber tube drainage, loosening the drain on the first or second day, removing it about the fifth to irrigate the tract, and then replacing it daily until discharge was diminished and tract clean. One of his cases develops a fecal fistula with the drain still *in situ* on the tenth or twelfth day. A discussion occurs at the bed-side and the rubber tube is blamed, perhaps justifiably. In his next few cases he either removes the rubber tube earlier or substitutes at operation a cigarette drain for the tube. If he decides to remove the drain earlier or shorten it a half inch daily, all goes well until some case develops a residual abscess at the depth of the tract; if he has transferred his allegiance to cigarette drains he may soon become dissatisfied on observing the inefficient drainage; an outpouring of an ounce or two of dammed-back pus on removal of the drain.

The results of the operators of long experience using standardized technic and not disturbed by the occasional wound complication, were, in general, better than those of men either attempting to individualize in their cases, or occasionally employing methods aimed at circumventing certain complications. Strangely enough, under the simple (as opposed to antiseptic) method of treatment the results attained under standardized but diametrically opposed methods were about the same.

There are certain underlying principles which all surgeons have in mind in the treatment of appendiceal infections. If at operation a well walled-off collection of pus is found and entered without contaminating the general abdominal cavity, the appendix is removed, if this can be done without breaking up protective adhesions, and the infected locality is drained. If free pus is present it is usually found in the pelvis and right lumbar gutter and drains are placed to these regions. As a rule, the drains are allowed to extend through the operative wound. Many have advocated and several practiced the separate drainage of the right lumbar gutter through a stab wound in the loin. The rationale of this procedure is unquestionably good from an anatomical viewpoint, as true dependent drainage is only in this way obtained. There have been no cases of vaginal or rectal drainage in this series. The drainage from the pelvis through tubes protruding from the abdominal wound is vertically upward with patient in Fowler or Gatch position. On the other hand, tubes to the right lumbar gutter in these positions have a horizontal direction or a few degrees of downward inclination. There were ten cases in which loin drainage was employed. All had retrocæcal, retrocolic or laterocolic abscess, three having retroperitoneal abscesses. Three cases resulted fatally, one from tuberculous broncho-pneumonia, the other two as a result of their infection which in each instance was of a severe

grade. In the 59 cases of latero- or retrocaecal and retrocolic abscesses drained through the anterior wound, drain was placed to the right lumbar gutter in 13 instances, and there was 1 death. This, at least, does not support the claims of decreased mortality made by some in favor of stab-wound drainage. On the other hand, it does not constitute a valid objection to its employment. Perhaps a greater argument than dependent drainage that might be urged in favor of loin drainage is that it permits the establishment of a straight tract. A drain placed to the lumbar gutter and emerging from an intermuscular or rectus incision must necessarily describe a curve, and the tube is therefore prone to buckle and prove inefficient. Tortuous tracts are often handled with success by late removal of the drain or the substitution of a small catheter after a few days, but they usually prove a worry.

Fenestrated, thin-walled, soft rubber tubes are to-day generally recognized as combining the highest grade of efficiency in drainage with the least danger of harm to the infected intestinal wall. The cigarette drain (gauze wapped with rubber tissue, rubber dam or gutta percha), while causing less pressure on contacting intestine, is quite worthless as a drain after a few hours. That cases do well with cigarette drains *in situ* is due to escape of exudate about the drain after it has been loosened, or, if multiple drains have been introduced, after the removal of one of them. In comparing the results of surgeons A. and B., the former, using cigarette drains, had 3 cases of fecal fistula in 30 cases; surgeon B. substituting a catheter for rubber tube drain on the second or third day had no fecal fistulae develop in his 28 cases.

The type of drain most frequently employed was the double-arm tube, devised by Dr. Joseph A. Blake. The tube is so fashioned that the deep ends of the two arms are held together by a narrow connecting portion of the tube wall. One arm is fenestrated and provided with a gauze wick which affords capillarity between the depth of the tract and the wound dressing. The wick also tends to prevent possible insinuation of a process of omentum into the lumen of the tube. The other arm is non-fenestrated and left open; it provides another avenue of escape of exudate, and permits the introduction of a catheter for irrigation at the daily dressing. Tubes of this type were used in 114 of the 263 cases (44 per cent.). Single fenestrated tubes with gauze wick were employed either alone, with the double arm tube, or multiple single tubes in 97 cases (37 per cent.). Cigarette drains, single or multiple, alone or with rubber tubes in 73 cases (28 per cent.). Gauze drains were employed in 22 cases and only as an adjunct to other drains, and were invariably removed early. Other drains occasionally employed were rubber dam in 4 cases, small rubber tubes inclosed in silk in 2 cases, Mikulicz drain in 1 case, and rubber tissue in 1 case.

Drain was placed to pelvis either alone or with drain to other regions in 144 cases (54.7 per cent.); to caecal region in 119 cases (45.2 per cent.);

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to right lumbar gutter in 23 cases (9 per cent.). In 10 cases a lumbar gutter drain was introduced through a stab wound in the loin. In 37 cases drains were placed both to pelvis and cæcal region. In a few instances other regions were drained, as the pathology required, *e.g.*, subhepatic abscesses. One subhepatic abscess was drained with success through the intermuscular incision, although the tract was necessarily a very long and a sharply angulated one. In one case the drain was placed just within the peritoneum, the abscess being procæcal. Drains in the superficial wound were introduced as adjuncts in 9 cases.

The post-operative care of the wound was various but found to resolve itself into (1) a loosening and gradual and progressive shortening of the original drains; (2) early or (3) late removal and replacement by the same size or smaller size drains or catheter, the wound usually being irrigated by saline or boric solution at the daily dressing. The first method of gradual shortening was employed in 62 cases (24 per cent.); in some of these cases a small drain was introduced after the late removal of the original drain. In 102 cases, 38.8 per cent., the original drains were removed and replaced either by the same or smaller tube during the first four days; in 111 cases (42.2 per cent.) replacement was effected subsequent to the fourth day. Daily irrigations were the rule in the tube-drain cases. With the double-arm tube this was accomplished early, before removal of drain, by loosening and slightly withdrawing drain and the introduction of the irrigating catheter to the depth of the closed arm. After a period of four to five days, the double tube was frequently removed, a catheter inserted to the depth of the tract and irrigation was followed by replacement of one arm of the tube. Another method has been alluded to, of replacing the drainage tube by a soft rubber catheter early or late, and allowing this to remain in the wound as a drain, and to facilitate daily irrigation.

The progress of wound infection and repair under these varying methods of treatment was strikingly similar; the results attained by men skilled in the employment of diametrically opposed procedures were almost identical. Taking the cigarette drained cases with late replacement, or gradual shortening with occasional or no irrigation in comparison with the tube-drained cases with early replacement and daily irrigation through catheter, the former reached a stage of clinical cleanliness when drainage could be safely discontinued in the average case on the fourteenth day; the latter on the sixteenth day. Evidence of inefficient drainage was noted in two cases of the former and only one of the latter. The character of discharge and infection of abdominal wall was similar—slough of aponeurosis was noted in 8 and 7 cases, respectively. Under the former treatment three fecal fistulæ appeared; one of these occurring in a tuberculous subject in which a tuberculous peritonitis was found at a later operation; no fecal fistula occurred in the latter. There was one case of secondary abscess under each type of treatment. Thrombophlebitis of internal saphenous vein occurred once in each group. The

wounds on discharge showed an interesting variation in the former, but three cases having a discharging sinus, in the latter seven cases. In general, however, the wounds showed similar stages of healing. The average hospital stay was twenty-three days in each. One death occurred in each. The follow-up cases yielded similar results in herniæ and weak abdominal walls.

In a perusal of the dressing notes of many of the cases, one cannot but be impressed by the number of manœuvres which were decidedly painful to the patient, and the net gain of which proved to be extremely small, if any. The practice, which has been rather common, of removing a large drainage tube from a deep tract which in many cases proved to be more or less tortuous, irrigating the tract and then attempting to reinsert the same tube, should certainly be condemned. The objections, if any, of replacement by a small drain are more than offset by the possible injury that may be done to the delicate wall of the drainage tract and the suffering caused by instrumental introduction of a large tube. With the technic of antiseptic treatment described in another paper,⁶ the patient can be said to enjoy complete freedom from painful dressings.

Viewed in the light of the post-operative course of the cases treated throughout by the introduction of adequate quantities of Dakin's fluid, the greater number of these 263 cases treated by simple drainage present an unattractive picture. It is quite analogous to the startling change said to have been made in the course of war wounds when treated either by débridement or by the Carrel-Dakin method.

An effort has been made to summarize the course of the cases as a whole, in regard to efficiency of drainage, wound complications, degree of suppuration, and destruction of abdominal wall tissues, including wound disruptions. There were 36 cases (14 per cent.) in which wound drainage was inefficient, evidenced by the sudden outflow of a considerable quantity of exudate on loosening or removing the drain. The causes were various: cigarette drains acting as plugs, buckling of the rubber tubes and clots of fibrin within the lumen of the tubes were found the more common. Hemorrhage from the wound occurred in 7 cases (2.7 per cent.); in one case a fatal issue was barely averted by transfusion and secondary operation for control. Hemorrhagic oozing was present in two other cases. It was possible to ascertain the degree of suppuration in 207 cases. Slight suppuration throughout was recorded in 19 cases (9 per cent.); moderate in 55 (26.5 per cent.), and profuse in 133 (64.5 per cent.). Odorless discharge was noted in but six of 179 cases (3.3 per cent.); foul discharge at some period of the post-operative course in 173 cases (96.7 per cent.). The presence or absence of slough was recorded in 143 cases. In 11 cases only did the histories indicate an absence of slough. In 31 cases

⁶ Rulison, E. T., Jr., M.D.: The Clinical Application of the Carrel-Dakin Method to Cases of Acute Appendicitis Requiring Drainage.

the slough was evidently superficial or from the abscess wall; in 100 cases there was a definite necrosis of the aponeurosis of the external oblique (70 per cent.). While at first glance this percentage may seem high, it was arrived at by as fair an interpretation of the records as was possible. A large number of cases in which dressing notes were meagre undoubtedly had slough of aponeurosis, but, of course, have been excluded. I believe that the number of cases of this kind excluded more than offsets the number in which no slough had occurred. That the sloughing out of the aponeurosis has been considered rather in the normal course of events in these drainage cases receives confirmatory evidence from the history notes. For example, in History No. 22071, on the sixth day "considerable slough removed from wound," and on the eighth day "sloughs are beginning to separate," and on the twelfth day "tubes placed to depth of pelvis relieving pocket at deep portion," and on the twenty-fifth day "patient leaves hospital with a discharging sinus, having made *an uneventful recovery*." In History No. 30374, on the eighth day a note was made of "considerable slough," and on the tenth day "large piece of sloughs removed;" on the forty-second day "wound healed with crust. sinus, having made *a good recovery*." In History No. 37256, on the tenth day "one slough of external oblique removed;" on the eleventh day "large sloughs removed;" on the twenty-fourth day "wound healed with crust. He had a *characteristic sloughing* of the wound with loss of much external oblique aponeurosis, leaving him with probable chances of ventral hernia."

A recent house surgeon asserted that during his service he had never seen an appendix abscess which had not sloughed out a portion of the aponeurosis. To quote from the records of some of the cases not making as good recovery as those cited above, in History No. 20366, on the fourth day "wound lined by slough, caput coli presenting;" on the ninth day, "cæcum bulged into wound and was packed back." In History No. 20602, on the sixth day "several sloughs removed;" on the eighth day "internal oblique separated 1 inch, intestine in wound." In History No. 33978 on the seventh day "much slough;" on the ninth day "great many stinking sloughs removed;" on the eleventh day "condition of wound fair, no sloughs." In History No. 36281, on ninth day, "large piece of slough;" on tenth day "several pieces of slough;" on the fourteenth day, "large piece of slough *with chronic sutures*;" on sixteenth day, "large pieces of slough." In History No. 37242 on the eleventh day "cellulitis with disruption of wound;" on the 13th day "enormous amount of slough, mostly aponeurosis, removed;" on the twenty-first day "one piece of slough." In History No. 33638, on the eighth day, "fecal fistula has appeared;" on the tenth day "gut in wound;" on the fourteenth day "wound a granulating cavity formed by coils of intestine and abdominal wall. Skin edges show effect of sloughing, having an irregular worm-eaten edge. Discharge a bright yellow liquid with curds." In History No. 20734, on the fifth day, "wound wide open, lined by sloughs; aponeurosis sloughing away;" on the seventh day "con-

siderable slough; " on the ninth day "abscess beneath the abdominal wall opened by finger drain;" on the tenth day "sheath of rectus entirely sloughed out." These quotations were taken almost at random from the 100 cases in which slough of aponeurosis was recorded. The character of discharge present, the foul, stinking "colon" odor that greets the surgeon when the bedclothes are turned down at the daily dressing, the odor that the patient has to endure for a period of a week or ten days and often longer, is familiar to all. The dressing notes abound in vivid characterizations of the odors emitted by the wounds.

Actual hernia of intestine into wounds was referred to in 9 cases, and a more moderate degree of wound disruption in 12. Mural abscesses occurred in 17 cases.

The average period of suppuration was estimated in 204 cases as 15.4 days. At the end of this period the wound might be said to be "clinically clean" and necessity of drainage no longer present.

Complications.—*Fecal fistulae* appeared in 18 cases, or 7.5 per cent. of the cases which recovered. There were two fistulae among the 24 fatal cases. Twelve fistulae closed spontaneously; two were closed by operative procedure and five failed to close. Three cases were discharged from the hospital with fecal fistula, one of these after an unsuccessful operative attempt at closure.

Analysis of these 18 cases of fistula yields the following data: In 10 cases rubber-tube drainage was employed, in 5 cases cigarette drains, and in 3 cases both rubber tubes and cigarette drains. In 15 cases the post-operative wound management consisted of a gradual shortening or a late replacement of drains by smaller drains or reinsertion of the original drain. In only two cases in which the original drain was early replaced by a small drain, that is, before the fourth day, did fistula develop. One of these two cases, History No. 35099, was treated by removal of the cigarette drain on the second day and attempt at replacement by a catheter failed. The case began to show a mounting temperature and on the fourth day a catheter was passed instrumentally in a direction the original drain had taken for a distance of six inches. On the tenth day a rubber tube was substituted and on the following day a fistula appeared. Evidence of injury to the drainage tract by forcibly introducing drains was found in 4 cases. There was one case of fistula resulting from deliberate opening of a knuckle of intestine in wound to relieve ileus.

Consideration of these findings lends evidence to the views generally held regarding the development of this complication. The prolonged tube pressure against an infected intestinal wall undoubtedly causes an area of localized necrosis. The very low incidence of fistula in cases treated by an early substitution of a smaller drain or catheter is strong confirmatory proof of this view. The importance of handling abdominal drainage tracts with gentleness is emphasized by the appearance of fecal fistula in 4 of 16 cases in which secondary wound procedures were necessary

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to improve drainage. In the antiseptic treatment of drainage tracts described in another paper⁷ these considerations are given due weight. Efficient contact of antiseptic with tract wall necessitates the early exchange of tube for catheter which is introduced with minimal injury to the tract wall. The tendency to restraint of infection afforded by the antiseptic may also prove a factor in lessening wall destruction.

Of the strictly abdominal complications, *secondary abscesses* furnished the greatest number. The 17 cases of mural abscess have been mentioned. There were 21 cases of secondary peritoneal abscess (8 per cent.), 12 in pelvic position, 3 subphrenic, 2 subhepatic, 2 right lumbar, 1 in subsplenic, and 1 in left lower abdomen. Spontaneous evacuation resulted in 3 cases through wound and in 1 case by rectum. Eleven secondary collections were drained by approach through wound, usually the insertion of a finger with patient under nitrous-oxide-oxygen anæsthesia. Six were drained through separate abdominal incisions. Abdominal masses thought to be secondary abscesses disappeared spontaneously in 3 cases.

Paralytic and mechanical ileus were comparatively rare complications, the former occurring in 7 cases (2.6 per cent.) and the latter in but 3 cases (1.1 per cent.). This excellent record is due, it would seem, to the close observation that the cases receive and deserve, and the prompt institution of treatment directed towards relief of complications. In general the management of a case with peritonitis of any degree has been to allow little or no fluids by mouth, colonic irrigations at intervals of six or eight hours, beginning about 12 hours after operation, gastric lavage repeated at intervals of six or eight hours if vomiting or distention indicate. Deficiency of fluids has been met by proctoclysis, hypodermoclysis, intravenous infusion of normal saline or glucose solutions. The withholding of fluids or food by mouth until gastro-intestinal peristaltic movements have become orderly usually affords the patient a course uncomplicated by paralytic ileus. Care in the placing of drains is, of course, an important prophylactic measure for ileus of mechanical type. The proper beveling of drainage tube ends and the compressibility of the tube walls are details of no little importance. When we reflect that it is asserted that it requires but a weight of 5 to 8 grammes to check the onward movement of contents in the dog's normal intestine,⁸ it is surprising that in these infected cases we meet the condition of mechanical ileus so infrequently.

Of the 10 cases of ileus, there were 3 deaths due to failure to relieve the condition. Of the 7 recovered cases, 4 recovered without surgical intervention and 3 after operative procedure for relief. Of the 4 recovering without operation, 3 were of paralytic variety, the other what was thought to be an early mechanical ileus. Two of the three cases recovering after operation were of the mechanical type. None of the mechanical ileus cases died of

⁷ Rulison, E. T., Jr., M.D.: The Clinical Application of the Carrel-Dakin Method to Cases of Acute Appendicitis Requiring Drainage.

⁸ Cash: Johns Hopkins Hospital Reports, i, 93, 1896.

the condition. Operation revealed adhesions with kinking of the intestine in one case, and obstruction from tube pressure in the other. Paralytic ileus in the three fatal cases was a terminal condition, a symptom of the unchecked progressive infection. In only one of these cases was operative relief attempted.

There were 3 cases of acute dilatation of the stomach, all being relieved by lavage and change of position.

Of the complications not immediately abdominal, those of the respiratory tract were most numerous. Acute bronchitis occurred in 2 cases, post-operative pneumonitis of lobar type in 17 cases (6.4 per cent.); broncho-pneumonia in 2 cases; empyema in 4 cases; pulmonary infarction in 3; pulmonary embolism in 2; pulmonary tuberculosis in 5 cases, making a total of 36 pulmonary complications, or 13.7 per cent. This high percentage, I believe, has not been generally recognized.

Urinary complications were infrequent; acute cystitis in 2 cases and acute uræmia in 2 cases.

Blood-vessel complications comprised 2 cases of thrombophlebitis of the internal saphenous vein and 1 case of embolism of the femoral artery with gangrene of the extremity; phlebitis occurred in one case.

Jaundice was present in 4 cases; acute exanthemata in 2 cases; a toxic erythema in one case that also suffered from an infectious psychosis. Acute rheumatic fever complicated 1 case; otitis media, 2 cases; enterocolitis, 2 cases. There were in all a total of 62 complications (23.6 per cent.) not immediately abdominal in character.

History No. 22301 serves as an illustration of the manner in which some cases may be beset by complications. At operation a gangrenous appendix with a large amount of free pus in the pelvis and right lumbar gutter was found. Visceral and parietal peritoneum showed pathological changes as far as exploration was carried. Operative diagnosis was acute appendicitis with acute diffuse peritonitis. Appendix was removed and a double rubber tube drain was placed to pelvis and a single tube to the right lumbar gutter. Culture showed *Bac. Coli Communis* and *B. Fecalis Alkaligenes*. The wound treatment consisted of loosening and shortening the drains a little on the second day and applying a camphor-wet dressing. On the fourth day the tubes were further shortened and the wound irrigated. Discharge from wound was foul dirty brown to light yellow during the first week and profuse green to thick mucoid during the second week. By the eighth day the wound was gaping and lined by slough. On the twelfth day the cæcum lay exposed in the wound with muscles widely separated; on this day an abscess pocket in the pelvis was opened through the wound. On the fifteenth day a subcutaneous abscess was opened through the wound. On the eighteenth day a secondary abscess to the inner side of the wound between peritoneum and muscles was opened through the wound. On the forty-first day a left thoracotomy was performed for em-

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pyema (culture streptococcus). On the forty-eighth day, fecal fistula appeared; on this same day a residual abscess subsplenic was opened through a left-sided incision. On the fifty-seventh day a small intestinal fistula appeared in the left side of the wound. This fistula closed spontaneously; the cæcal fistula was closed successfully by operation at the fifth month. The patient left the hospital after a stay of 205 days. Three years after the operation he was found to be in good general health. Ventral hernia was present.

Secondary procedures instituted for relief of immediate or remote complications totalled 43 (16.4 per cent.). The following is a list of these operations:

Secondary abscesses (mural or peritoneal)	23
Opened through wound	16
Opened through separate incision	7
Ileus	4
Mechanical	2
Paralytic	2
Fecal fistula	3
Exploratory for residual abscess not found	3
For control of hemorrhage	1
For recovery of fecolith	1
Secondary suture of rectus muscle	1
Skin-graft of wound	1
Amputation of leg (embolism of femoral artery)	1
Thoracotomy	5
<hr/>	<hr/>
Total	43

Late secondary operations will be referred to under follow-up results.

Conditions of Wounds on Discharge from Hospital.—Seventeen cases left with wounds completely healed (7.3 per cent.); 9 cases left with wound area covered by an apparently healthy crust (3.8 per cent.); 87 cases were discharged with small granulating areas at the site of drainage tract (37 per cent.); in 7 cases the granulating area was a large one (3 per cent.); in 43 cases a sinus was present, but discharge negligible (18.5 per cent.); in 66 cases a discharging sinus was noted (29.1 per cent.); 3 cases left with a fecal fistula in one of which operative closure had been unsuccessful. In 8 cases the condition of wound on discharge was not recorded.

The general condition of patients on discharge was good. In a few instances (four) the records state that "patient has lost considerable weight during stay in hospital." The weight of patients on admission and discharge has not been recorded in any of the cases.

The average duration of the hospital stay of the 240 recovered cases was twenty-six and five-tenth days. Late secondary procedures, *e.g.*, repair of ventral hernia, appendicectomy, etc., added one and five-tenth days to the average, making twenty-eight days. The shortest stay was eleven days; the longest two hundred and five days.

Deaths.—There were 24 deaths in the 263 cases; one occurring after a

late secondary operation (subsequent hospital admission), making 9.1 per cent. mortality. The mortality of the different groups is given in Table II.

Fifteen deaths were directly attributable to the peritoneal infection. Pulmonary embolism was given as the primary cause of death in 3 cases. In one of these at autopsy a thrombosis of right and left internal iliacs and infarcts of lung were found. Embolism of the femoral artery with gangrene of the leg and deep sacral decubitus caused death in one case. Pylephlebitis, tuberculous broncho-pneumonia, inanition as a result of a high intestinal fistula, and long continued sepsis resulting from multiple foci (subdiaphragmatic abscess, empyema with fecal fistula) were responsible for four of the deaths. One case was readmitted to the hospital after seven months with acute ileus from band, causing gangrene of a loop of ileum. Death followed resection.

Autopsies were performed in only 3 cases. One has been mentioned. The other two were cases of acute diffuse peritonitis at operation, and death in each case occurred on the seventh day. In one case there were well formed adhesions about the drainage tube but diffuse peritonitis. In the other a progressive fibrino-purulent peritonitis had ensued, numerous pus pockets and areas of necrosis were present in the intestinal walls.

Records of Follow-up Clinic.—One hundred and sixty-five of the 240 cases were followed up over a period of two months to two years (69 per cent.). The cases in which follow-up results are wanting were for the most part private patients.

The time of ultimate closure of the wound was mentioned in 36 cases and the average time after leaving the hospital estimated at five weeks.

Reappearance of discharge from wound occurred in 11 cases (4.6 per cent.). In 4 of these cases chromic sutures were expelled after prolonged periods of discharge.

Time of resumption of work in 17 cases averaged eight weeks. In 2 cases there was prolonged disability; in 1 incapacity for work existed for fifteen months.

The symptomatic results were for the most part excellent. In only 5 cases were there symptoms indicative of residual intra-abdominal pathological conditions.

The records are particularly complete in regard to the condition of the abdominal wall. The weak walls at the site of scars have been noted and described as "bulges," and the term ventral hernia reserved for cases in which a distinct neck could be palpated and definite impulse at the neck felt when patient coughed. "Bulges" or weak walls were noted in 29 cases (18 per cent.) and hernia in 33 cases (20 per cent.). The anatomical results were therefore poor in 38 per cent. of the cases.

Operations for repair of ventral hernia were done in 8 cases with 6 successful results. Hernia operations have been delayed until eight months to a year for two excellent reasons. First, there have been several cases of weak walls with decided bulges which have disappeared spontaneously

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as the abdominal musculature gradually improved in tone. In one or two instances an examiner has actually recorded a hernia which at a later examination failed of verification. A second reason for delay is that pyogenic organisms probably remain enmeshed in the scar tissue of these wounds for a considerable period and militate against success in the hernial repair.

Late Secondary Operations.—In addition to the 8 operations for repair of ventral hernia, there were 3 subsequent operations for removal of appendix in cases that had previously been treated by simple incision and drainage. There was one late operation for closure of fecal fistula. Two cases re-entered the hospital with acute ileus. One has been described under deaths; the other re-entered the hospital seven days after discharge and a peritoneal band from scar to brim of pelvis was divided, the patient making a good recovery. Late residual abscesses occurred in two of the cases, one an omental abscess, admitted eleven months after discharge with history of repeated attacks of abdominal pain and symptoms of partial ileus. Omental abscess was excised and the patient left the hospital after a stay of forty-eight days. A large ventral hernia developed at the site of second operative scar. The other patient entered the hospital five months after discharge and a retrocæcal abscess containing about 100 c.c. of foul pus was opened.

There was a total of 16 late secondary operations (6.6 per cent.) with one death.

We have found in the cases reviewed that the average period of supuration was fifteen and four-tenth days, during which time the wounds discharged foul pus and sloughs. The average duration of hospital stay was twenty-eight days. Among the frequent complications fecal fistula developed in 7.5 per cent. of the cases. Anatomical results were poor in 38 per cent. of the cases. There was a 9.1 per cent. mortality. Whether the course of these cases may be improved in any of these essential particulars by the use of antiseptics is dependent upon their safe application and a determination of their efficiency in this type of infection. A consideration of the post-operative antiseptic treatment of cases of acute appendicitis requiring drainage appears in another paper.⁹

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ANKYLOSING OPERATIONS ON THE TUBERCULOUS SPINE*

LABORATORY EXAMINATION OF A SPECIMEN

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IN the eight years that have elapsed since Hibbs and Albee published descriptions of their operations for ankylosing the spine, various authors have reported many cases, but only a few, laboratory examinations of specimens.¹

My patient was a boy of four years with typical history, symptomatology, and Röntgen picture of tuberculosis of the tenth thoracic vertebra, upon whom I did a Hibbs operation on August 26, 1918. After the operation the child was put upon a Whitman-Bradford frame, and remained on it until October 25, when he was put in a plaster jacket. During this time he suffered at intervals from pain in the abdomen.

The pain grew worse after the application of the jacket, and the child could hardly walk.

On December 24 the jacket was removed, and a small fluctuating swelling was discovered on the third and fourth ribs at their junction with the sternum. The boy was put back upon his frame, and was started on the sunlight treatment. Another skiagram was made of his spine. This showed "disease in the lower thoracic vertebræ, involving especially the tenth and eleventh. Probable union of the eighth and ninth, tenth and eleventh and twelfth. No definite union between the ninth and tenth."

The cold abscess on the front of the chest slowly increased in size, and was repeatedly aspirated. The guinea-pig test proved its contents to be tuberculous, but its origin was never determined. It ruptured and became infected in the following March.

January 31, 1919: Second operation. Dissection of scar. Long incision carried down to vertebræ at site of previous operation. The lateral masses were then laid bare. Bony union had been attained for the most part, but was not complete in one or two places. The laminæ were carefully bared, and, where non-union was suspected, a chip was turned down from their lower border, as in the Hibbs operation.

A piece of the cortex was removed with a circular saw from the antero-medial aspect of the tibia, and was sutured tightly to the laminæ with kangaroo tendon slightly to the right of the middle line. Dry dressing. Patient put back on his frame.

* From the Stanford University Laboratory of Surgical Pathology.

¹ Ely: "Ankylosing Operations on the Spine." A Study of Two Specimens in the Laboratory. *Journal of the American Medical Association*, 1917, lxxviii, 183. Gallie: *American Journal of Orthopædic Surgery*, 1916, xiv, 137.



FIG. 1.—Posterior aspect of specimen.

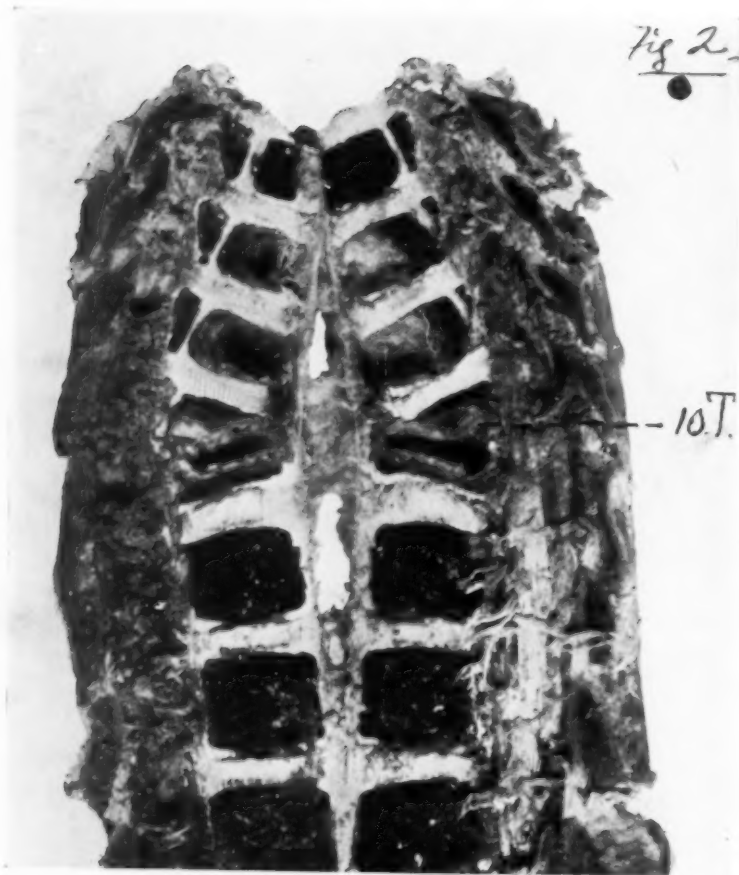


FIG. 2.—Specimen laid open from behind.

ANKYLOSING OPERATIONS ON THE TUBERCULOUS SPINE

All went well for the next two months, except as to the rupture of the abscess.

In early April the child began to have vomiting spells. Slowly typical symptoms of meningitis developed. Smears from clear fluid withdrawn by spinal puncture showed 95 per cent. lymphocytes and 5 per cent. polymorphonuclear cells, but no bacteria or acid fast bacilli.

Death April 22, 1919. No general autopsy was permitted. The affected portion of the spine, however, was obtained.

Examination of the specimen posteriorly showed a tightly adherent periosteum. When this was dissected off, a solid bridge of bone uniting the eighth, ninth, tenth, eleventh, twelfth thoracic and first lumbar vertebræ was discovered. This bridge of bone is seen to be the result of the union of the laminæ, produced by the Hibbs operation, reinforced by the graft, which is apparently firmly united to the lateral masses. The bony structure of the graft is continuous with that of the receiving bones (Fig. 1).

Anteriorly, the bodies of the eighth, ninth, and tenth thoracic are badly diseased. A large part of them evidently has been destroyed, especially on the left side. Fluctuation can be detected under the periosteum on the anterior surface in all three.

The specimen was sawn sagittally, and split open from behind (Fig. 2). Marked involvement of the eighth, ninth, and tenth vertebræ was disclosed. Each of them contained a large cavity filled with necrotic material, fluid and semisolid. Indeed, little bone remains in their left halves, and not much more in their right.

The tenth thoracic vertebra is of the usual wedge shape seen in spinal tuberculosis, as the X-ray showed it to be before the first operation, but the eighth and ninth, though almost as badly involved, have been kept from collapsing by the bony bridge of the laminæ. In spite of this bony bridge the disease has steadily progressed.

Histologically the specimen showed typical tuberculosis of the marrow, but no tubercle bacilli were found. The disease was of the rapid destructive type with practically no tendency to encapsulation by fibrous tissue.

After eight years it is possible to draw certain conclusions in regard to these ankylosing operations for spinal tuberculosis.

1. They are curative in a large proportion of cases of what was previously an almost incurable disease.

2. They are not invariably curative. Unlike ankylosing operations on other joints of the body, they ankylose neighboring joints, not the diseased ones, and hence simply provide a splint for the affected region. They provide rest, nothing more. They put Nature in the best possible position for accomplishing a cure herself, but they cause no change in the affected tissues. The lymphoid marrow and the synovial membrane still exist, and afford the proper food for the tubercle bacillus. Consequently we occasionally observe a steady progress of the disease, and

must do another operation above or below the first one, when the tubercle bacilli invade the bone marrow above or below the ankylosed area.

3. These operations shorten greatly the length of the treatment and make it much simpler. Complications, such as abscess formation and paraplegia, usually are not met with after them. Apparently they often cure paraplegia.

4. They are serious operations. Several deaths have been reported, due directly to the operation.² Death is sometimes caused by the anæsthetic. Hence, these operations should never be done without a skilled anæsthetist. The patient should always be anæsthetised in the prone position, with an arrangement of cushions under his shoulders and hips that will enable him to breathe comfortably.

5. None of my grafts has ever separated, nor have I had any serious infection, nothing but a late infection caused by a tight jacket, with the sequestration of a small piece of graft. Other operators have observed the late separation of the graft after an Albee operation. I have operated in the neighborhood of an infected lumbar abscess, and my wound has healed by first intention.

6. Opinions as to the relative merits of the two operations differ. Personally, I prefer the Hibbs operation, but it is much the more difficult. I never undertake it in the lordotic lumbar spine. It usually takes almost two hours, while the Albee operation should take about forty-five minutes, perhaps less.

²Baumann: *Cleveland Medical Journal*, 1917, xvi, 657. Patient died while being turned before operation. John: *American Journal of Orthopædic Surgery*, 1916, xiv, 450. One case forty hours after, of ether pneumonia. Wolcott: *Journal American Medical Association*. Résumé of work of others, 1916, lxvi, 110. One from shock one day after. Albee: One from fat embolus, Ryerson. Lambert: *Medical Journal of Australia*, 1918, i, 529. One next day, unknown cause. Wierzejski: *Beiträge zur klinischen Chirurgie*, 1914, xciii, 653. One case fat embolus one hour after operation, but this was with the author's modification of Albee operation. One case seven hours after operation, embolus. Gaenslen: *Wisconsin Medical Journal*, 1916, xv, 465. One case three hours after operation, enlarged thymus. Ely: *Journal of American Medical Association*, 1917, lxviii, 183.

AN EXPERIMENTAL STUDY OF BURIED BONE*

BY LEONARD W. ELY, M.D.

OF SAN FRANCISCO, CAL.

THIS study is supplemental to one made in collaboration with Doctor John Francis Cowan.¹

The material used was obtained at a series of knee-joint resections on dogs. In some the bone fragment was buried as removed, in others it was first boiled. The bone was always buried deep in the thigh muscles of the animal from which it was removed, immediately on the completion of the resection, and the wound was sutured and dressed.

Ether anæsthesia invariable. Skin preparation of shaving, soap and water, bichloride of mercury solution, and alcohol. The wounds healed by first intention.

The animals died or were sacrificed 17 days to 1103 days (three years) after operation. The material was removed with the surrounding tissue, fixed in alcohol or formaldehyde solution, decalcified in 5 per cent. nitric acid, run through the alcohols, imbedded in celloidin (or a substitute), and stained with hæmatoxylin and eosin and with the van Gieson stain.

Following is a protocol of the experiments:

Dog 23.—975 days. Unboiled femoral condyle; diligent search at autopsy failed to discover it.

Dog 24.—694 days. Large piece of raw bone; diligent search at autopsy failed to discover it.

Dog 26.—Seventeen days. Piece of head of tibia, unboiled. Cause of death, pneumonia.

The buried bone is dead. Its lacunæ are empty. New bone trabeculæ are forming in the adjacent periosteum at part of the circumference. Live cells appear in the bone at the circumference of the buried piece in the neighborhood of the articular cartilage, and bone production apparently is beginning here also. In the interior are collections of polymorphonuclear cells, some of which stain fairly well, and give the tissue the appearance of lymphoid marrow, but no reticulum is present, and no blood-vessels. A reticulum is present near the periphery, and blood-vessels are seen pushing their way into the bone. The process of vascularization is most active in those portions of the bone that are covered by periosteum. Rarefying osteitis, typical, is going on here, but not in the interior, and here also the blood sinuses are engorged, as is customary in animals dying of infectious disease. The cartilage cells stain rather poorly, and except those close to the bone, they have lost their capsules. The basement substance is breaking up and is becoming fibrillated.

Recapitulation.—Death of bone and marrow. Formation of new bone, revascularization and rarefying osteitis at and near the periphery.

Dog 27.—473 days. Large piece of head of tibia, unboiled. The piece of bone is decidedly decreased in size, and has a definite capsule of fibrous tissue with which it is intimately connected.

The bone tissue is small in amount. The trabeculæ are scant. The cortex is thin and in places is wanting. Most of the bone is dead, but many of the trabeculæ show live

* From the Stanford University Laboratory of Surgical Pathology.

¹ Cowan and Ely: "A Study of Buried Bone," *The Journal of Orthopædic Surgery*, 1919, i, 109.

bone cells, especially near their margin—"border apposition." The marrow is about one-half fibrous, and one-half fatty. The trabeculae, living and dead, are intimately connected with the marrow tissue. No sign of cartilage is present, but this may be due to the place of sectioning.

Recapitulation.—Decrease in size of fragment. Decrease in amount of bone tissue. Most of the bone is dead. Some is living. Fibrous and fatty marrow.

Dog 28.—374 days. Piece of condyle, unboiled. The fragment is small in size, much smaller than when buried. It does not possess a complete, definite capsule. The marrow is about one-half fibrous and one-half fatty. The two are not mixed, but the fibrous marrow occupies the middle portion, streaming in from the side not covered by cartilage. Its fibres appear to run into the bone trabeculae and blend with them. The cartilage is in a good state of preservation, though slightly irregular in places at its surface. Fibrous tissue has also replaced its superficial portion at the sides. The cartilage cells stain fairly well, and capsules can be distinguished about most of them. The bone buttress is absent under much of the portion underlaid by fatty marrow, thick and persistent under that portion underlaid by fibrous marrow. The marrow contains blood-vessels, and shows no sign of necrosis.

The bone tissue is dead for the most part; the lacunae are empty, but many of the trabeculae show life at their edges, with sharply staining cells, and there are a few trabeculae under the cartilage, lying in the midst of dead bone, whose basement substance stains sharply in contrast to that of the dead bone, and whose cells also stain. They are evidently alive.

Recapitulation.—Decrease in size of fragment. Death of bone, with some new bone deposited, especially on the margins of the dead trabeculae. Fibrous and fatty marrow. Persistence of cartilage.

Dog 29.—1103 days. Large piece of femoral condyle, unboiled. The bone is a mere shell, and cuts easily with a knife. The bone fragment is markedly decreased in size, and is everywhere intimately connected with the surrounding tissues. It is a mere shell, and in places even this shell has been replaced by fibrous tissue. The bone trabeculae are very few and small—mere fragments—but they are all alive. The bone cortex, where it exists, is very thin, but also alive. The marrow is exclusively fatty. The cartilage exists as three irregular islands, separated by narrow wedges of fibrous tissue. One of the lateral islands is rather thin, and its superficial portion has been replaced by fibrous tissue. Its cells stain, but many of them have lost their capsules, and the cartilage appears to be reverting to fibrous tissue. The other lateral island is somewhat thicker, and shows marked evidence of calcification in its deeper portion. Here the cells retain their capsules, but in the superficial uncalcified portion the capsules are not so well marked. The middle island is irregular in shape and structure. One side of it shows the structure of the adjacent island, and the other, of the other island. Only indications of a bony buttress persist here and there.

Recapitulation.—Marked decrease in size and consistency of the fragment. Decrease in size of cartilage. Live bone and cartilage. Fatty marrow. No sign of necrosis.

Dog 31.—922 days. Large piece of condyle of femur, unboiled. The buried bone has a well-defined capsule of connective tissue. It has not decreased greatly in size. For the most part, a thin layer of cortical bone lies directly beneath this, but in certain stretches this layer is absent, and the fibrous capsule bounds the marrow. About three-quarters of the marrow is fatty, the rest, at one end of the bone, is fibrous. Calcification is prominent in this region. The bone cells stain well. Evidently most of the bone is alive; some of it is dead. The trabeculae are somewhat sparse. No normal cartilage is present, but a thin layer of "osteoid" tissue eroded at its surface replaces it. This contains some columns of cartilage cells and other cartilage cells in groups and singly, living and dead. A few small vessels appear in the marrow, and several engorged blood sinuses.

Recapitulation.—Little decrease in size. Trabeculae somewhat scant, but mostly alive. No cartilage present.



FIG. 1.—Dog 26.

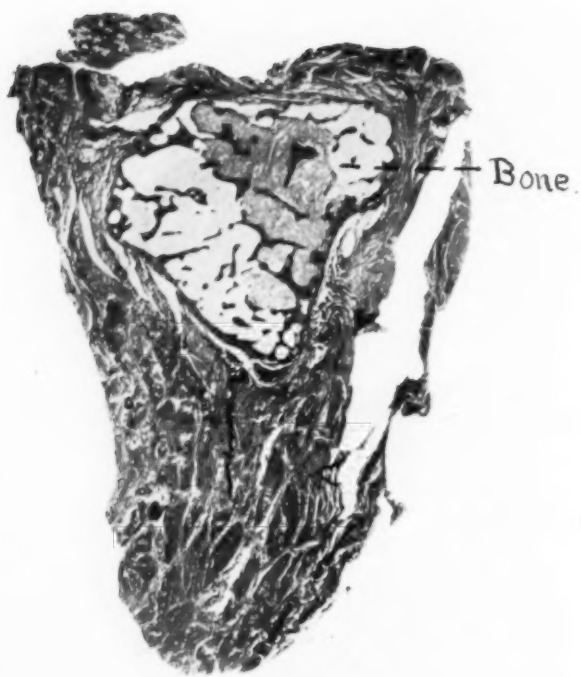


FIG. 2.—Dog 27.

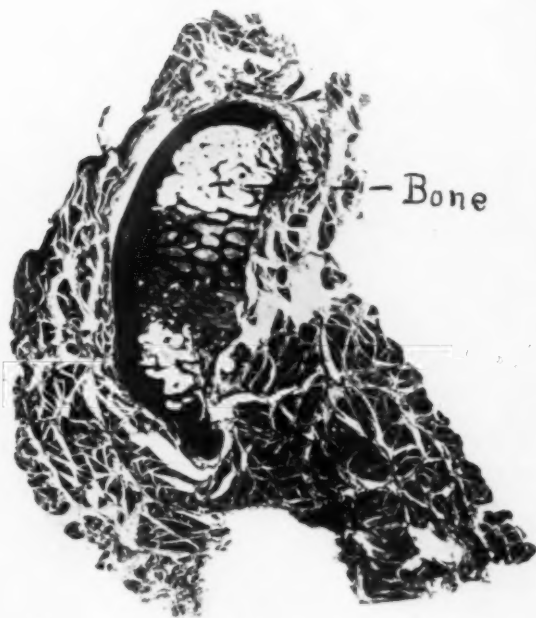


FIG. 3.—Dog 28.

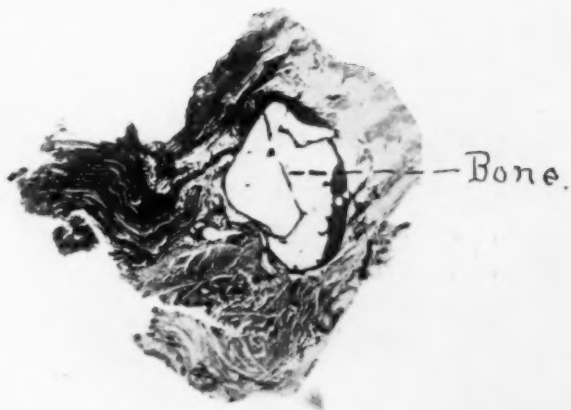


FIG. 4.—Dog 29.

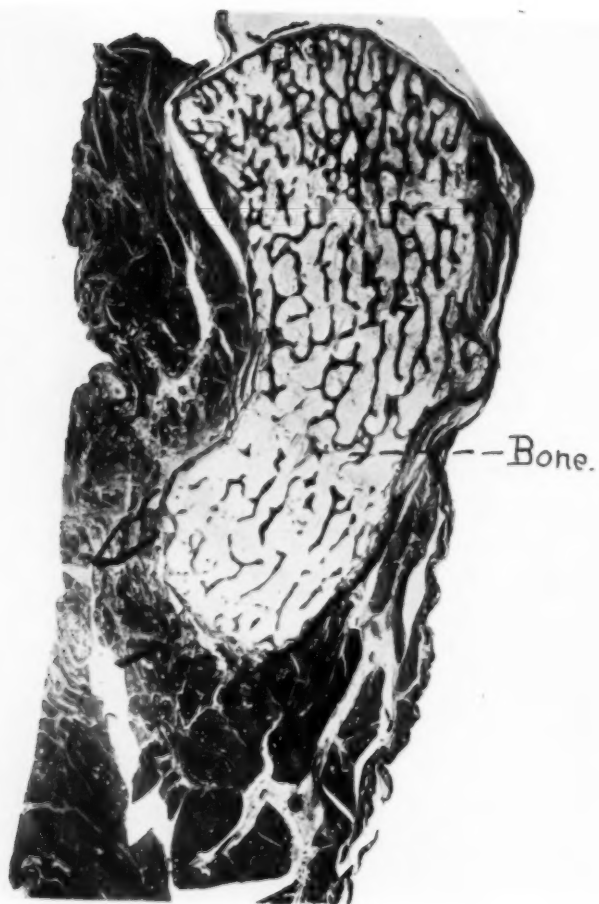


FIG. 5.—Dog 31.

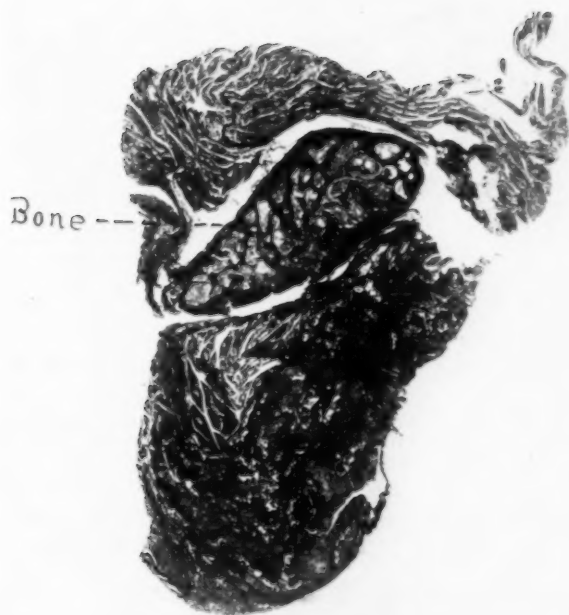
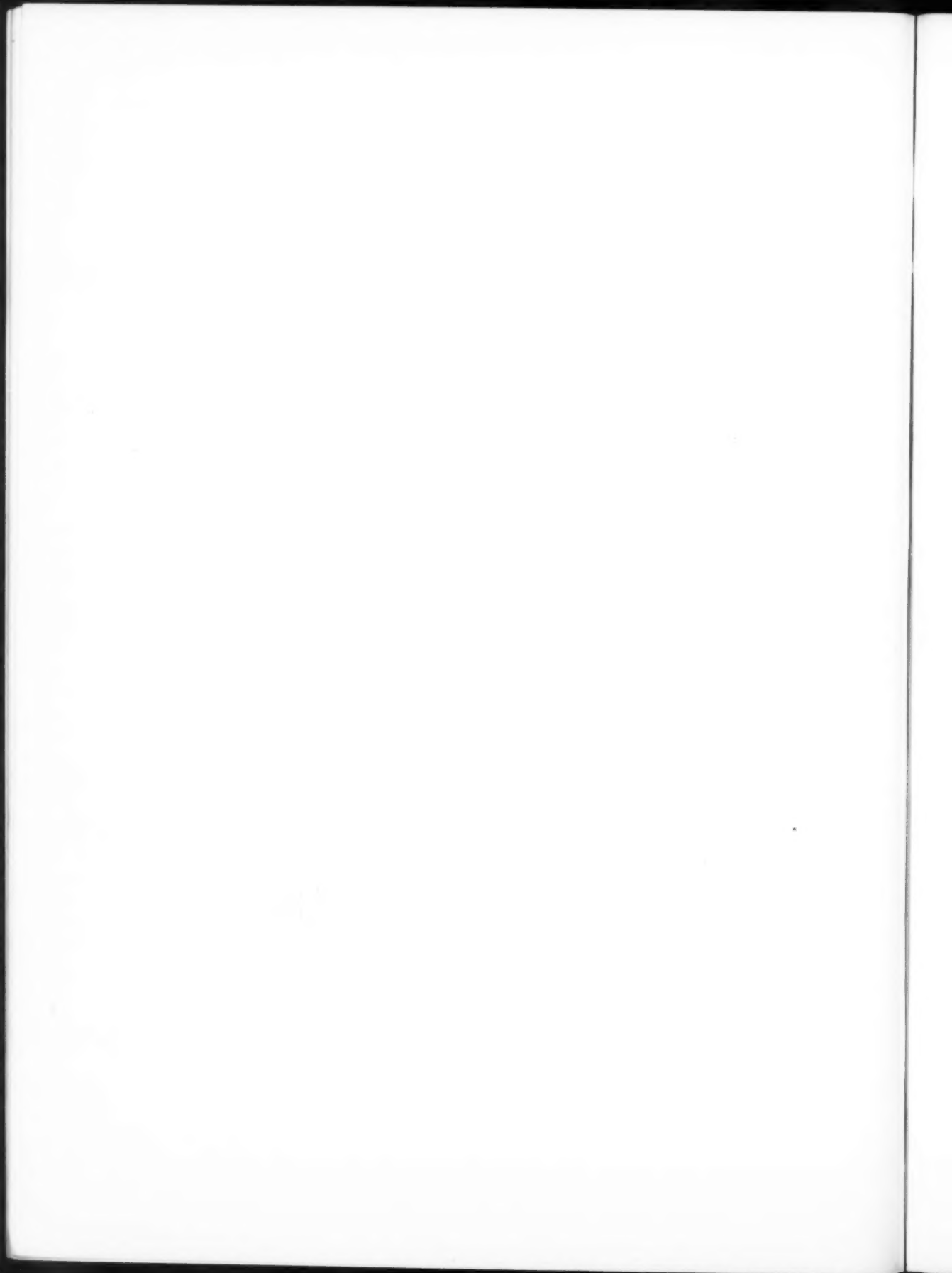


FIG. 6.—Dog 36.



EXPERIMENTAL STUDY OF BURIED BONE

Dog 32.—720 days. Large piece of boiled femoral condyle; diligent search at autopsy failed to discover it.

Dog 33.—930 days. Piece of boiled tuberosity of tibia; diligent search at autopsy failed to discover it.

Dog 35.—790 days. Large piece of boiled bone; diligent search at autopsy failed to discover it.

Dog 36.—150 days. Large piece of head of femur, boiled. The fragment is very small in size, and is encapsulated with fibrous tissue. Nothing like a cortex is present, except for a short distance. The marrow spaces are bounded by the connective-tissue capsule. The trabeculae are of about the normal number and size, but they are dead. Those at one side of the section, however, show live bone at their margins. Many of the dead trabeculae show the typical "bitten out" appearance of rarefying osteitis, but no evidence of activity is present in the process except in the part where the live bone is. The marrow is almost exclusively fibrous. One small area of fatty marrow forms the exception. No cartilage is present, but this may be due to sectioning.

Recapitulation.—Very great decrease in size. Dead bone, a little living bone. Fibrous marrow. No cartilage.

Dog 37.—544 days. Small piece of boiled tibial tuberosity; diligent search at autopsy failed to discover it.

SUMMARY

Twelve experiments, 7 with raw bone, 5 with boiled. Of the 7 with raw bone, in 2 the bone could not be found, one after 975 days, one after 694 days.

Of the 5 with boiled bone, in 4 the bone could not be found, one after 720 days, one after 930 days, one after 790 days, one after 544 days.

In the 5 other experiments with raw bone, the fragments were recovered after 17 days, 473 days, 374 days, 1103 days, and 922 days.

In the other experiment with boiled bone, the fragment was recovered after 150 days, but it was very small.

In other words, no boiled bone was recovered after 150 days, while raw bone in one case persisted for 1103 days—3 years, 7 days. *Raw bone resists absorption better than boiled bone, but it also is slowly absorbed.*

A decrease in size of the fragment was almost invariable. Generally, also, it decreased in density—exception, one boiled piece.

Generally the conclusions reached in the former study are confirmed, but this series indicates, in addition, that the bone and marrow in the buried fragment both die. The marrow is then re-formed by blood-vessels pushing in from the surrounding tissues, and a certain amount of new bone is laid down upon the old, especially along the margins of the trabeculae. The cartilage usually lives, but slowly becomes eroded at its surface, and becomes thinner. Its buttress soon disappears.

Dog 26 shows well the influence of the periosteum in bone formation. The periosteum does not "form" bone, but bone is formed in it. The portion of the dead bone adjacent to it is more quickly vascularized and hence is earliest the seat of new bone formation.

NOTE.—The illustrations are all low-power photomicrographs, magnified 5 diameters. This gives an idea of the decrease in size, with Dog 26 as a standard, though, of course, no attempt was made to measure the exact size of the fragment when it was imbedded.

THE SELF-RETAINING SLIDE BONE GRAFT*

BY HARVEY C. MASLAND, M.D.

OF PHILADELPHIA, PA.

POSSIBLY no field of surgery in recent years has shown more brilliant achievements than have been obtained in plastic bone work. A perusal of the literature accumulated in the last five years demonstrates that from the earlier apparently contradictory explanations of bone regeneration there has developed a more definite comprehension of the rôle of the periosteum and of the osteoblasts and osteoclasts. Their activity has been studied in both the resident and the implanted bone. Gallie and Robertson have appealed to me as giving a logical and plausible explanation of the regenerative process. In condensed form, the degree and rapidity of regeneration depends on: the close contact of the bones, the number and vitality of the osteoblasts, and the opportunity offered for the continued subsistence of these osteoblasts.

In recent fractures where the osteogenetic functions of the ends are sufficient with coaptation to produce union, they believe a boiled bone plate as satisfactory as an autogenous plate. This expedites the operation and eliminates structural weakness in the bone from which the autogenous plate is taken.

It might be remarked here that the open operation for fractures should be used only when the older standard methods do not promise a good result.

My experiments, using a bone plate and bone screws and either a surface contact or a partial inlay on the fractured bone, gave a good mechanical result and in selected cases should give a good final result.

It is my thought, however, to consider the suggestions that these men and others have offered that make for the success or failure of plastic bone surgery, and apply them to the self-retaining slide graft procedure.

First, in plastic bone surgery the need of faultless aseptic surgery is absolute. This applies to the hands. It may be that a glove can be as sterile as an instrument, but if the operator trains himself not to touch the bone with his hands, it will have a salutary effect on other details.

All traumatism should be eliminated as much as possible. This can be accomplished best by a power-driven bone-cutting equipment. All the bone cutting necessary is done without force, with accurate control and minimum wastage.

The bones should be made to contact with the highest possible degree of accuracy. The vitality of the contacting surfaces is of the highest degree of importance. It is unfortunate that the universal motor, so ad-

* Read before the Section on Surgery of the Pennsylvania State Medical Society, September 25, 1919.

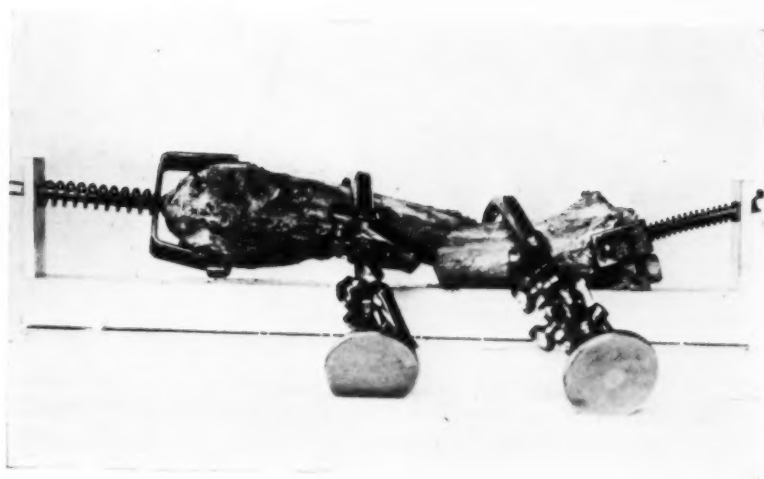


FIG. 1.

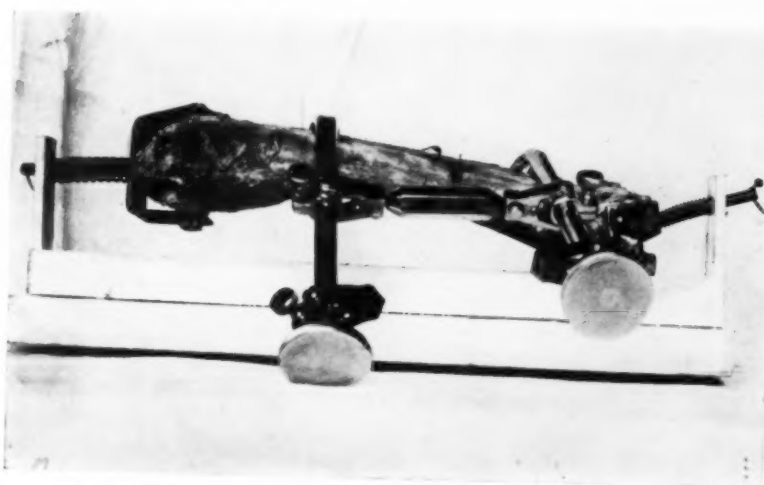


FIG. 2.

SELF-RETAINING SLIDE BONE GRAFT

vantageous in other respects, rotates the circular saw at such high speed that carbonization of the bone is inevitable without a constant drip. A low speed motor, though handicapped in that it must be used for the direct or alternating current individually, is preferable because it eliminates burning and so preserves the life of the contacting osteoblasts.

The bones should be held as rigidly as possible. Absorbable sutures, which are the only kind recommended for this purpose, will stretch and allow play in the jointing. Where bone pegs alone are used and held by virtue of being forced in, the pressure may cause atrophy and lessen the vitality of the region involved. Further, they can slip before the repara-

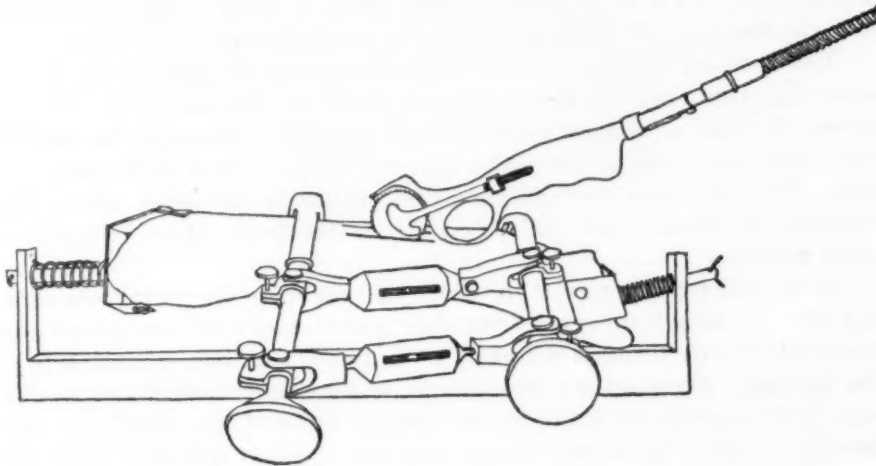


FIG. 3.

tive process has advanced sufficiently to nullify the consequences of their giving way. Logically, then, the bone screw is most desirable. It turns in readily, presents a larger surface for osteogenetic repair, and cannot slip. This paper is not considering the subject of metallic plates, wires and screws. Their only excuse to-day is that the facilities are not at hand for doing better work.

Bone plates, screws and pegs, either autogenous or heterogenous, and chromicised gut will meet all the demands, and being absorbable will not give the proportion of subsequent complications.

The surgeon should be prepared at the time of operation to do a bone plating, either partially inland or after the more common Lane method, or some slide graft procedure. The decision would depend upon the site of the fracture and the size and conformity of the bones as to the method chosen.

The difference between the self-retaining and the ordinary beveled graft is that the bevel is cut in opposite directions. In the self-retaining graft the saw undercuts the wall of the remaining bone shaft. Its advantage is that the wall of the shaft prevents the graft from springing out.

While the ordinary plate can be lifted out readily, the self-retaining plate must be dislodged and slid along within the course of the gutter. This is not as difficult as one might think. The cut is made twice as long on one side of the fracture as the other. Not less than one inch on one side and two inches on the other side should be made. During the operation the replacement clamps are holding the fractured ends in position. If the shorter graft cannot be tilted and removed, a flange on one side can be cut off and the plate readily slips out. This short graft can be sliced and used for bone screws. Not infrequently the bone is too thin to make a good screw. It is my belief that heterogeneous boiled screws and pegs will answer, and it is advisable to have them at hand. This does away with the necessity of attacking the tibia for additional bone.

The ordinary beveled graft, if sutured in place, will inevitably spring somewhat from its seat, as the greatest strain is resisted by the sutures alone. If bone screws are used they must be passed through the medullary canal and threaded into holes into the compact bone of the opposite side. Oblique holes through the bone cannot be threaded unless the entrance be countersunk and this weakens the bone where strength is most required.

In the self-retaining graft the shaft wall prevents the graft from coming out. To keep it up against the shaft gutter, two holes are drilled and threaded directly through the graft toward each end, one on each side of the fracture. Bone screws are inserted and passing through the medullary canal impinge on the opposite compact bone of the shaft. By continuing to turn the screw after it hits the opposite compact bone the graft is forced upward until it is tight against the gutter wall. Oblique holes are drilled through the side walls of the shaft catching the graft at its lower edge. These act as shelves supporting the graft in position and preventing sinking in. As the strain is not in a direction to force them out, they do not have to be forced in, but just a snug fit.

I have made a number of photographs showing the different stages of the operation. A bone mounted to simulate a fracture gives opportunities for better views.

Figs. 1, 2 and 3 show the replacement clamps reducing the fracture and holding it in accurate position for the subsequent manipulations. The specially new feature of this clamp is the universal joint connection of the separating mechanism, with the clamp shaft. This permits any movement necessary to bring the bones into perfect position. By tightening a few wing nuts the clamps are made rigid in their final position.

Recent fractures usually do not require much force for replacement, but in any case the clamps serve a useful purpose in preventing the fragments from continually slipping during the manipulations of permanent fixation.

The circular saw shown in Fig. 3 cuts with the accuracy and control of a scalpel. The trim cut without waste possible with a circular saw,

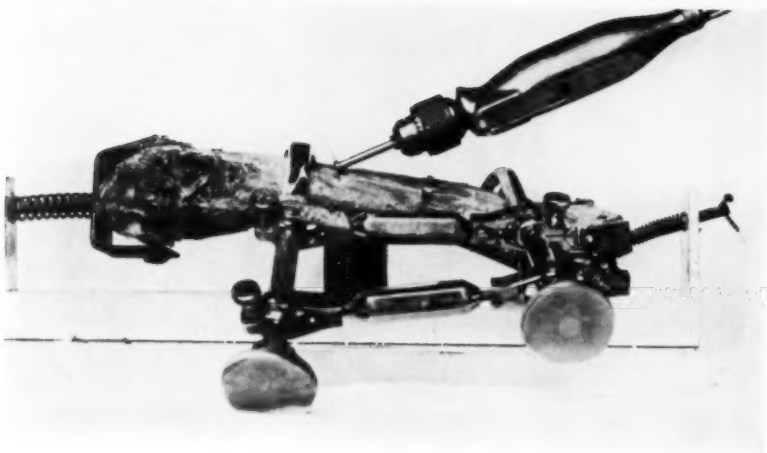


FIG. 4.

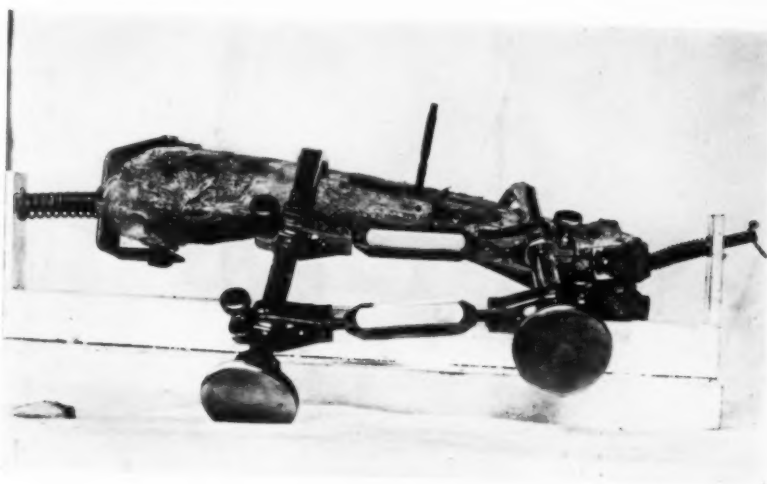


FIG. 5.

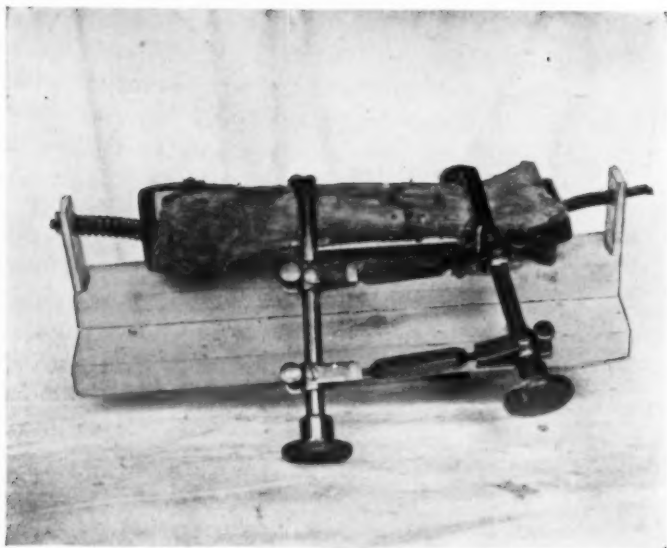


FIG. 6.

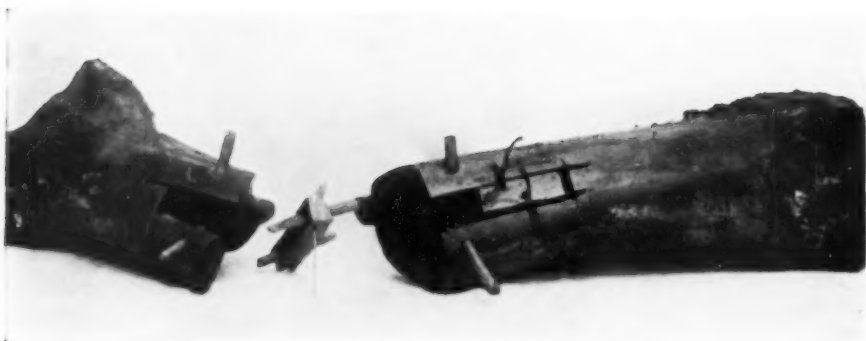


FIG. 7.

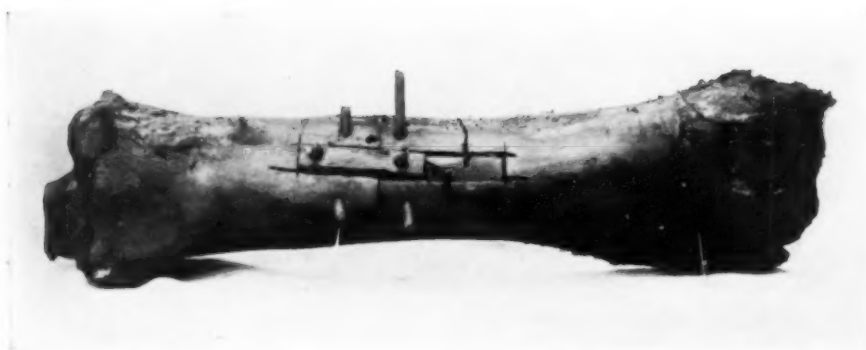


FIG. 8.

SELF-RETAINING SLIDE BONE GRAFT

and its quickness of execution are sufficient recommendations for its universal adoption.

Other tools now provided working with reliability and accuracy practically bring a machine shop to the operating table.

The other illustrations with the explanations that have been given and the footnotes do not need further comment.

In operating, the anticipated steps of the procedure should be carefully planned so that the various tools are not needlessly rehandled and the element of time is conserved.

It will be seen that in this method the advantages are that the bones are brought into good alignment. There are no sutures to slip. No metallic material is present. The bone grafts cannot slip. The strength of the graft plus its bracing is the index of the strength of the jointure. The requirements laid down for the greatest likelihood of regeneration and union are adhered to.

THE USE OF METALLIC FIXATURES IN SECURING BONE FRAGMENTS

PRESSURE ANALYSIS AND A NEW METAL BONE BOLT

BY WILLIAM LISLE BELL, M.D.
OF OAKLAND, CAL.

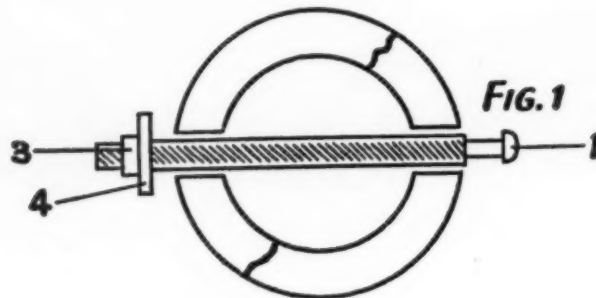
DESPITE the recent revolution against metals, many operators continue and will continue their use, and will be for some time unequipped with the intricate devices necessary for all autogenous work.

The methods of Albee and his contemporaries offer to most of us a nearer approach to the ideal. Autogenous work is promised a wider acceptance when more men become equipped and technically familiar.

In the interval many surgeons will adhere to metallic fixtures, and it is with a desire to simplify some of these methods as well as to place particular emphasis on devitalizing crushing metal pressures, that these arguments are put forth.

Many still adhere to the methods of Lambotte, and in spirals, or obliques, where the bone, if laterally held, is self splinting, use some form of through and through fixture.

The bolt answers these requirements.



The objection has been that the nut must be placed on the deep end, and the bolt measured and cut first or later cut with difficulty and at an improper angle.

The space needed for these manipulations in the deeper tissues entails undue trauma and loss of time. Trauma may be lessened and time shortened with the quick locking bolt now to be described.

The bolt is shaped as illustrated in Fig. 1.

Modus.—1. Incision and reduction.

2. Clamp bone in accurate approximation.

3. Drill through both sides, large enough to admit bolt head No. 1.

4. Nut and washer Nos. 3 and 4—Fig. 1—are not removed from bolt.

5. Bolt inserted through drill hole head first—i.e., with nut proximal to operator.

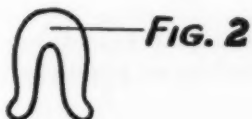
METALLIC FIXATURES IN BONE FRAGMENTS

6. Split washer—Fig. 2—is held by any properly curved light forceps, with a small longitudinal groove filed on the inner side of the blades at the point. Lock nut, Fig. 2, now slipped over inner bolt end, as in Fig. 4, No. 5.

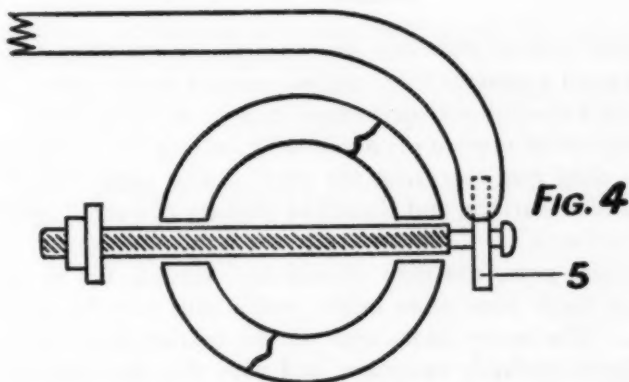
7. Bolt now drawn firmly toward the surgeon locking the inner end automatically as in Fig. 5, No. 6.

8. Nut turned up till washer just touches and projecting end cut on the accessible outside.

9. Efficient, sterilizable bolt cutters at any hardware store. No special instruments, not even screw drivers, needed,



- Technical Advantages.*—1. Short incision, brief anæsthetic.
2. Holding surfaces large enough to absorb stress.
3. Little bone periphery constricted.
4. Excellent holding equation against rotation, side slipping, and angulation in one, sometimes all planes.
5. In bolting where both sides are approachable through a stab wound, the older plain bolt answers fully as well.



Long transfixing screws in many places do not hold as dependably as bolts, and unless very carefully placed and self-reaming, impose an expansive force, and if too vigorously tightened, a contractile stress which very soon means loosening from surrounding bone.

These pressure remarks apply to all screws or vise-like arrangements, with or without plates.

The screw when forcibly tightened is making a violent and continu-

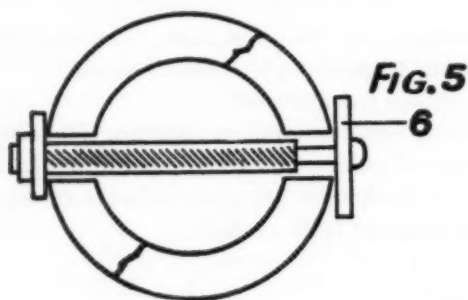
ous crushing effort to extricate itself from the bone and if the stress is maintained long enough and violently enough, it always succeeds.

The surgeon who has not experimented has little conception of the violent crushing exerted by a small screw when working against a wall of steel, or two opposing fragments of bone, or of the expansive force exerted when a tapered screw is driven home.

Albee has shown us some excellent examples of this in his volume. If the X-rays of plate failures are closely inspected, it will be observed in many that not only has the screw *killed* the bone directly encircling it, but that the plate was compressed violently enough against the compact layer of bone to produce pressure absorption for almost the entire under surface of the plate.

To a degree the avoidance of this condition is simple.

Use (if you must) a machine or parallel-sided self-tapping or cutter-pointed screw.



With a drill hole of sufficient size, turn the screw slowly forward half a turn, backward a quarter turn, and so onward until seated.

This screw cuts rather than wedges its way into the bone.

The compression pressure is avoided by seating the screw until it just touches but does not compress the plate. The plate should be more convex than bone surface, and should be slightly bowed to avoid pressure at fracture surfaces.

Bone levers, prys, spatulas should be avoided, for in prying and wrenching of fresh bone ends much periosteum may be separated and driven back. The many tables now on the market furnish an excellent means for most *operative* extension, and with slow intermittent pull, irritable muscles may be fatigued in a way to extend without violent saddle pressure, ankle or knee pull.

Pressure, to my mind, has never been sufficiently emphasized, and it is probably the most outstanding cause for premature loosening, infection, and malposition.

I have watched this work impartially in the hands of hundreds of men in many lands and a faultless technic cannot be too strongly enjoined, but a so-called faultless modus becomes faulty indeed when at the very heart of

METALLIC FIXTURES IN BONE FRAGMENTS

its faultlessness, lies a strangled and crushed bone. We are facing these days two diametrical schools, the one ultra-scientific, the other ultra-mechanical. Both are invaluable when reciprocal, both a fine art, but the mechanical without gentleness and infinite care presents dangers.

A third source of dangerous pressure I have been unable to find in print. It is the placing of a plate on fractured ends in slight overextension or separation. This brings the full approximating force of fragments against screw sides. This may be done through overextension or inaccurate rotation placement, with subsequent slight slipping.

In this respect, the larger *bolt* with its prevention of rotation, larger softer surfaces which prevent spreading, its freedom from expansive pressure, and easily avoided vise action (except what is unavoidably imposed by the fragments themselves) offers a much more ideal fixture than the plate and screw. Where the fracture is at all spiral or oblique, and not too comminuted, a loop of gut or other absorbable material may be thrown over the bolt ends and loose fragments lashed down without completely encircling the periosteum.

Fracture surfaces, wherever possible, should stand on their own ends, *without anything but a decided minimum of super-imposed trauma.*

Résumé.—1. No created *pressure*. Let the internal splint act as purely a *holding device*, not a crushing device that imposes many times the requisite amount of *force*,

2. No overburden or increased trauma—no prying, wrenching, and tearing away of periosteum, with pinch bars.

3. Dry incisions on closing.

4. Gradual and intermittent extension with *heavily* padded saddle. Minimum perineal pressure, ankle and knee pull.

5. Compression at fracture area, metal gauze sub-splint (see more refined apparatus (Hennequin), Dehelly and Lowey, *ANNALS OF SURGERY*, April, 1919, page 367).

6. No suture pressure in fascia. It will cicatrize or approximate later if not infected.

LEFT BRANCHIAL CYST OPENING ON THE RIGHT SIDE

BY ADDISON G. BRENIZER, M.D.

OF CHARLOTTE, N. C.

CASE I.—A young man, nineteen years old, first noticed a swelling on the right side of the front of his neck, below the Adam's apple, in December, 1918. The swelling was lanced by his physician and extruded a yellowish slimy substance. The incision partly closed, but continued to run. In February of this year he was taken to a surgeon, who opened the swelling the second time and scraped it out. Again the incision partly closed, but the discharge continued. In April the surgeon operated, dissecting and scraping out the surrounding tissue, but the result was ever the same; it continued to drain.

The patient presented himself with the right lower side of his neck considerably scarred, with a fistulous opening discharging a thick mucous pus. A curved incision was made, from left to right, across the neck as for a thyroidectomy, similar to the Kocher collar incision, but allowing the incision to divide over the right of the neck, so as to encircle the cicatrix and the mass. The skin flaps were dissected upward and downward. With the area of scarred skin left attached, the enlargement, *en masse*, was dissected out and traced, from right to left, upward across the sternohyoid muscles and thyroid cartilage, under the anterior belly of the omohyoid muscle and along the deep vessels of the neck up to the hyoid bone. On crossing the midline of the neck, the mass became attenuated into a fistulous tract, open, however, and admitting a probe up to the hyoid bone. The skin flaps, with platysma muscle, were brought back over the neck and closed, with a small tape drain in place. The drain was removed after forty-eight hours and the wound healed *per primam*. This was three months ago and since that time I have seen the patient frequently and found his neck healed and smooth.

Diagnosis.—Left branchial cyst opening on the right side.

Of the four branchial clefts and intervening branchial arches in the four weeks' foetus, only the first cleft should persist, forming the hyomandibular cleft, from which develop the ear, auditory canal, Eustachian tube, etc. The other three should coalesce in foetal life, leaving the neck smooth. If closure does not take place, these clefts persist as congenital formations, known as branchial cysts or fistulae.

These fistulae may (a) Open into the pharynx and, at the same time, open on the skin; (b) they may open only outwardly; (c) they may open only inwardly; or finally, (d) they may have neither outer nor inner opening and may thus persist as blind fistulae. These fistulae may persist as

LEFT BRANCHIAL CYST OPENING ON THE RIGHT SIDE



FIG. 1.—Diagram of the cyst, projected to the surface, along with the thyroid cartilage and trachea.
(1) Hyoid bone; (2) omohyoid muscle; (3) sternomastoid muscle.



FIG. 2.—Showing the cyst in relation to the musculature of the neck. (1) Hyoid bone; (2) thyroid cartilage; (3) cyst; (4 and 5) internal jugular vein and carotid artery.

mere tracts, lined by hypoblast within and epiblast without, separated by a layer of mesoblast.

My case was of the last type, having neither outer nor inner opening and persisted latent and not making itself known from foetal life to the nineteenth year, at which time it likely became cystic through the cellular activity and secretions of its lining cells, aided by infection and pointed on the right side of the neck. Sebaceous cysts, we know, commonly behave in this way.

Branchial fistulæ or cysts usually open on the same side where they take origin. The explanation why this left-sided cyst opened on the right side might be made in two ways. First, and the more probable: As the cyst increased in size and weight through the accumulation of secretions, by gravity and by virtue of fluid pressure, it pushed its way down the left side of the neck, to be turned across the midline to the right side by the anterior edge of the left sternomastoid muscle. Second, and less likely: There may have been persisting an anlage of a fistula on each side of the neck, a short lower end on the right, with a coalescing across the midline.

This case is interesting through several facts, namely: that the branchial fistula persisted for nineteen years before it became cystic and made itself known; that it pointed on the opposite side; that it was thrice previously operated on, and that the condition was cured only by its recognition and its complete dissection and removal.

To Contributors and Subscribers:

All contributions for Publication, Books for Review, and Exchanges should be sent to the Editorial Office, 145 Gates Ave., Brooklyn, N. Y.

Remittances for Subscriptions and Advertising and all business communications should be addressed to the

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227-231 S. 6th Street

Philadelphia, Penna.

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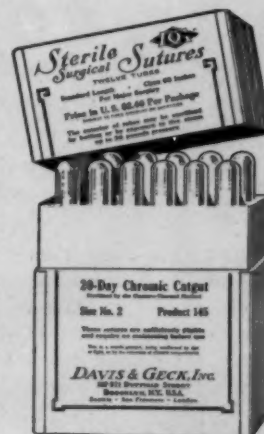
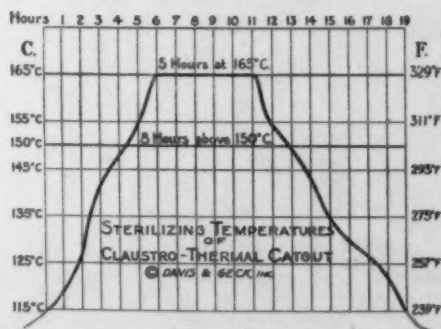
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An Improved Germicidal Suture Superseding Iodized Catgut

KALMERID CATGUT not only is sterile, but, being impregnated with potassium-mercuric-iodide—a double iodine compound—the sutures exert a local bactericidal action in the tissues. The older practise of impregnating catgut with the ordinary crystalline iodine for this purpose was at best an unsatisfactory method, since the antiseptic power was but slight and transient. The most serious deficiencies of such iodized sutures, however, were their instability and weakness arising from exposure to light; the deterioration resulting from the continuous and unpreventable oxidizing action of the iodine; and the disintegration of the sutures when heated. Moreover, the decomposition products of iodine caused such sutures to be irritating.

These serious disadvantages of iodized catgut have been overcome through the use of potassium-mercuric-iodide instead of iodine. This double salt of iodine and mercury, the chemical formula of which is $HgI_2 \cdot 2KI$, is one of the most active germicides known, exerting a killing action on bacteria about ten times greater than that of iodine. It does not break down under the influence of light or heat, it is chemically stable, and, in the proportions used, is neither toxic nor irritating to the tissues. It interferes in no way with the absorption of the sutures, and is not precipitated by the proteins of the body fluids.

Kalmerid catgut, in addition to its bactericidal attribute, embodies all the essentials of the perfect suture. It is perfectly compatible with the tissues, its absorbability is dependable, and its tensile strength is particularly good.

TWO VARIETIES—To meet the requirements of different surgeons two kinds of Kalmerid catgut are prepared—the boilable, and non-boilable.

BOILABLE GRADE—This variety is prepared for surgeons who prefer a boilable suture such as the Claustro-Thermal product, but possessing bactericidal properties in addition. The boilable grade, therefore, besides being impregnated with potassium-mercuric-iodide, embodies the desirable physical characteristics of the Claustro-Thermal sutures. It has the same moderate degree of flexibility; it is the same in appearance; it is tubed in the same improved storing fluid—toluol; and, after impregnation with potassium-mercuric-iodide, it further receives the Claustro-Thermal sterilization—that is, heat sterilization after closure of the tubes.

NON-BOILABLE GRADE—This variety is extremely pliable as it comes from the tubes. It is made for those surgeons who have been accustomed to the flexibility of iodized catgut.

Reprints of original articles relating to Kalmerid sutures will be sent upon request.

List of Kalmerid Catgut

Approximately Sixty Inches in Each Tube

Boilable Grade		Non-Boilable Grade	
Plain Catgut.....	Product No. 1205	Plain Catgut.....	Product No. 1405
10-Day Chromic.....	Product No. 1225	10-Day Chromic.....	Product No. 1425
20-Day Chromic.....	Product No. 1245	20-Day Chromic.....	Product No. 1445
40-Day Chromic.....	Product No. 1285	40-Day Chromic.....	Product No. 1485

SIZES: 000...00...0...1...2...3...4

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Price in U. S. A.

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In packages of twelve tubes of a kind and size as illustrated on first page

Kalmerid Kangaroo Tendons

Two Varieties—Boilable and Non-Boilable

THESE are the sutures *par excellence* for those procedures in which post-operative tension is excessive, or long continued apposition necessary, such as in herniotomy, and in tendon and bone suturing. Kalmerid kangaroo tendons not only are sterile, but, in addition, they are impregnated with potassium-mercuric-iodide, which enables them to exert a local bactericidal action in the tissues. The impregnating and sterilizing methods are the same as practised in the preparation of Kalmerid catgut, and described on the preceding page.

They are genuine kangaroo tendons; they are round, smooth, straight, of uniform contour, and possess a tensile strength about twice that of the best catgut of equivalent size.

Because of their greater strength some surgeons prefer these tendons, particularly in the finer sizes, to catgut for general intestinal, muscle, fascia, and skin suturing.

ABSORPTION TIME—The tendons are chromicized, and so accurately is the chromicizing process regulated that each size, whether it be the finest or the coarsest, will maintain apposition in fascia or in tendon for approximately thirty days. Shortly after that period the sutures, with their knots, will be completely absorbed.

TWO VARIETIES—Kalmerid kangaroo tendons are prepared in two grades—boilable and non-boilable.

The **NON-BOILABLE** tendons are extremely pliable and consequently require no moistening.

The **BOILABLE** tendons are quite stiff as they come from the tubes, but may be rendered pliable by moistening in sterile water preliminary to use. The smaller sizes will be sufficiently softened by fifteen minutes immersion, while the larger sizes should be immersed for about thirty minutes. Either sterile water, or an aqueous bactericidal solution made with Kalmerid tablets—1:5000—should be used.

Before immersion, the toluol, which is very volatile, should be allowed to evaporate so that the water may have access to the sutures.

Reprints of original articles relating to Kalmerid sutures will be sent upon request.

List of Kalmerid Kangaroo Tendons

Each Tube Contains One Tendon Lengths Vary From 12 to 20 Inches

The Non-Boilable Grade is *Product No. 370*

Boilable Grade is *Product No. 380*

Sizes

Tendon Sizes:	Ex. Fine	Fine	Medium	Coarse	Ex. Coarse
Catgut Sizes:	0	2	4	6	8

Please specify clearly the **PRODUCT NUMBERS** and **SIZES** desired

Kalmerid kangaroo tendons are unaffected by age or light, or by the extremes of climatic temperatures

Price in U. S. A.

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In packages of twelve tubes of a kind and size as illustrated on first page

Actual Sizes

000	_____
00	_____
0	_____
1	_____
2	_____
3	_____
4	_____
6	_____
8	_____

Standardized Sizes

The Established Metric System of Catgut Sizes
is Now Used For All Sutures

IN conformity with the long recognized need for a unified system of sizes, the standard metric catgut scale has been extended to embrace all sutures, including kangaroo tendons, silk, horsehair, silkworm gut, and celluloid-linen thread.

The advantage of this standardized system is obvious.

Miscellaneous Sutures

Boilable

Sterilized by Heat After Closure of the Tubes

Product No.	Material	Approximate Quantity in Each Tube	Catgut Sizes
350...	Celluloid-Linen Thread.....	60 Inches.....	.000, 00, 0
360...	Horsehair.....	Four 28-inch Sutures.....	.00
390...	Plain Silkworm Gut.....	Four 14-inch Sutures.....	.00, 0, 1
400...	Black Silkworm Gut.....	Four 14-inch Sutures.....	.00, 0, 1
450...	White Twisted Silk.....	60 Inches.....	.000, 00, 0, 1, 2, 3
460...	Black Twisted Silk.....	60 Inches.....	.000, 0, 2
480...	White Braided Silk.....	60 Inches.....	.00, 0, 2, 4
490...	Black Braided Silk.....	60 Inches.....	.00, 1, 4
600...	Catgut Circumcision Suture.....	30 Inches With Needle.....	.00

Price in U. S. A.—Per dozen tubes (subject to a fixed discount on quantities)\$2.40

In packages of twelve tubes of a kind and size as illustrated on first page

Minor Sutures

Short Length - Without Needles

Sterilized by Heat After Closure of the Tubes

Product No.	Material	Approximate Quantity in Each Tube	Catgut Sizes
802...	Plain Catgut.....	20 Inches.....	.00, 0, 1, 2, 3
812...	10-Day Chromic Catgut.....	20 Inches.....	.00, 0, 1, 2, 3
822...	20-Day Chromic Catgut.....	20 Inches.....	.00, 0, 1, 2, 3
862...	Horsehair.....	Two 28-inch Sutures.....	.00
872...	Plain Silkworm Gut.....	Two 14-inch Sutures.....	0
882...	White Twisted Silk.....	20 Inches.....	.000, 0, 2
892...	Umbilical Tape.....	Two 12-inch Ligatures.....	

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With Needles as Illustrated

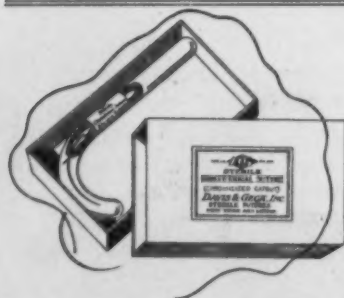
Sterilized by Heat After Closure of the Tubes

Product No.	Material	Approximate Quantity in Each Tube	Catgut Sizes
904...	Plain Catgut.....	20 Inches.....	.00, 0, 1, 2, 3
914...	10-Day Chromic Catgut.....	20 Inches.....	.00, 0, 1, 2, 3
924...	20-Day Chromic Catgut.....	20 Inches.....	.00, 0, 1, 2, 3
964...	Horsehair.....	Two 28-inch Sutures.....	.00
974...	Plain Silkworm Gut.....	Two 14-inch Sutures.....	0
984...	White Twisted Silk.....	20 Inches.....	.000, 0, 2

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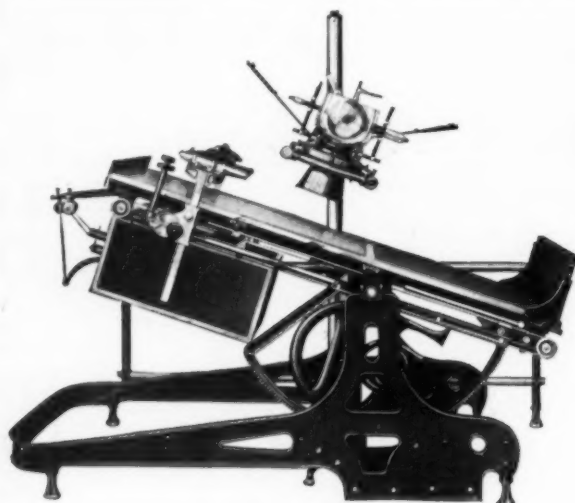
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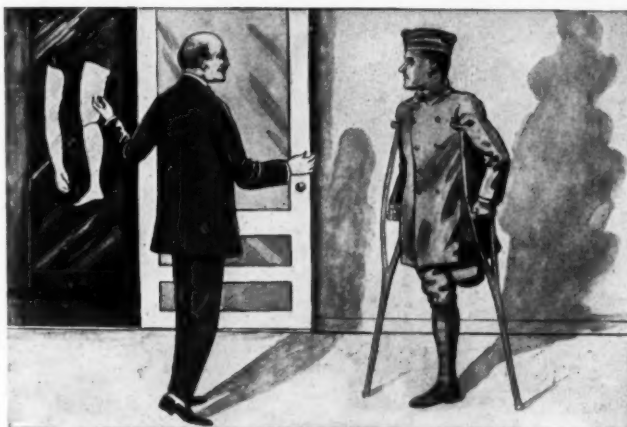


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Vol. I

DECEMBER, 1919

No. 1

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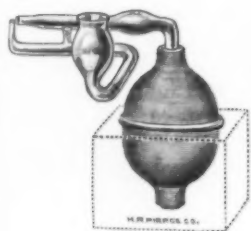
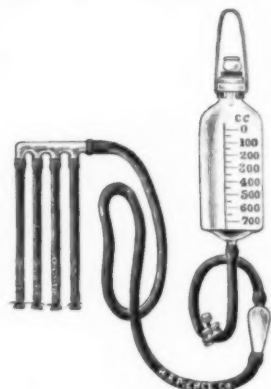
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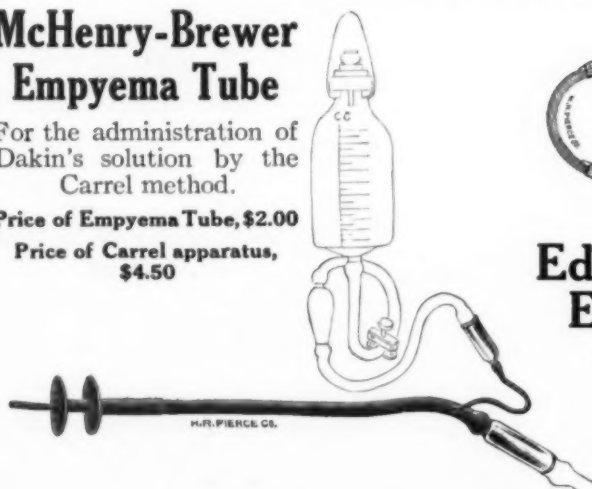
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By **DR. LEONARD FREEMAN, M.D., Denver, Colorado**

Read before the Oregon State Medical Society, June 21, 1919. See page 231, August, 1919, Annals of Surgery.



PLATE 2. Side view of Bone Clamp.

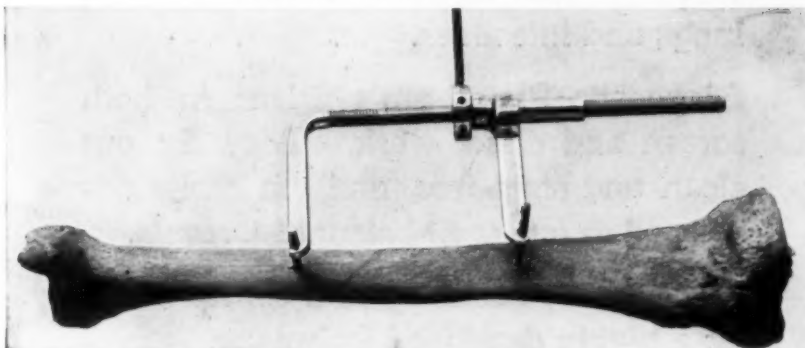


PLATE 5. Turnbuckle in position for applying extension.

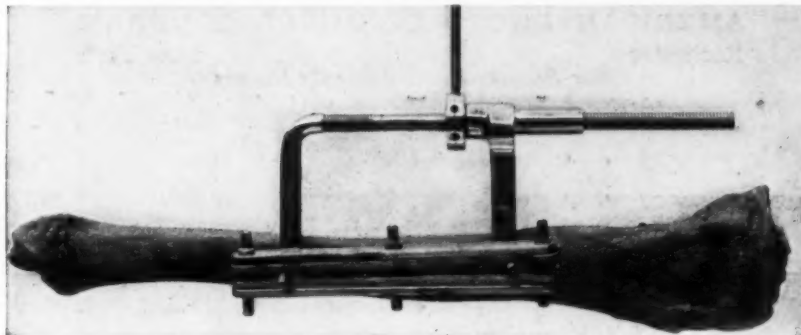


PLATE 6. Bone Clamp in position before removal of Turnbuckle.

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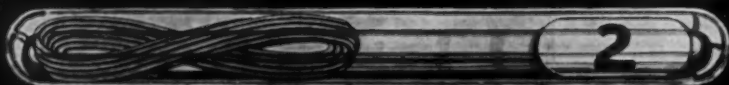
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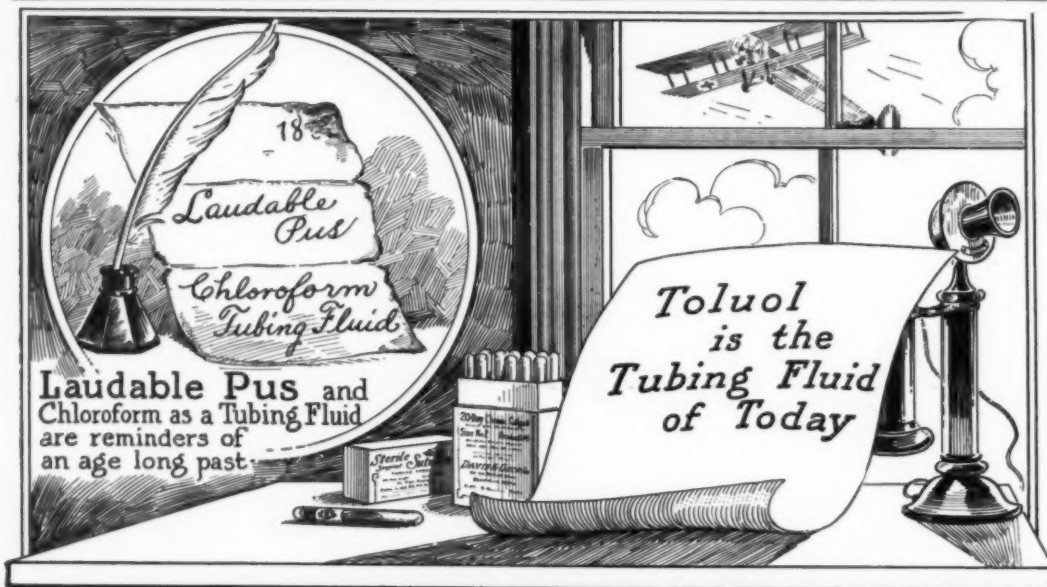
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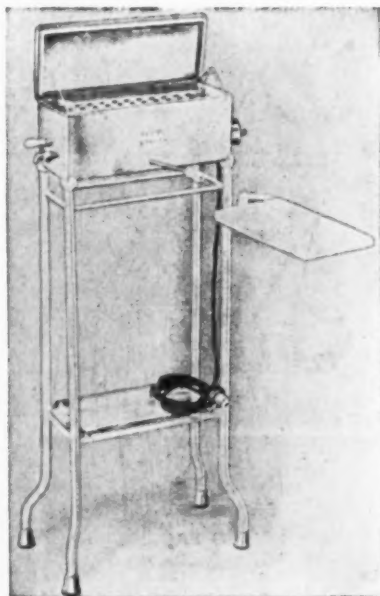
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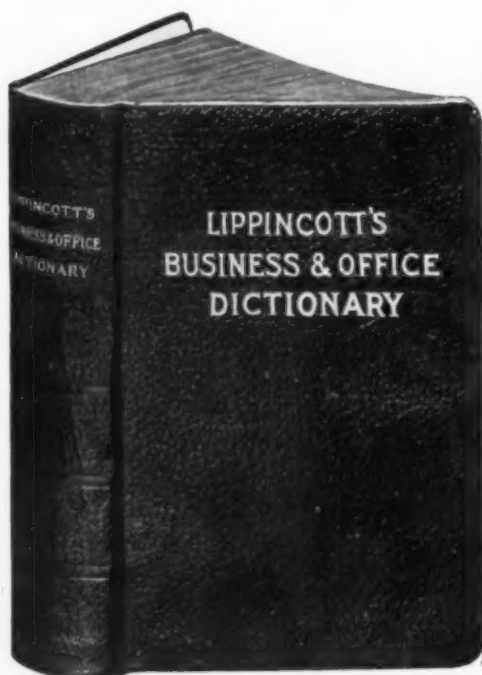


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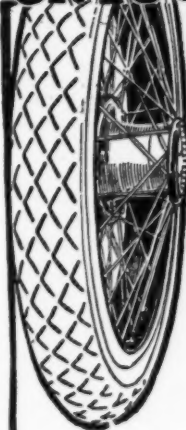
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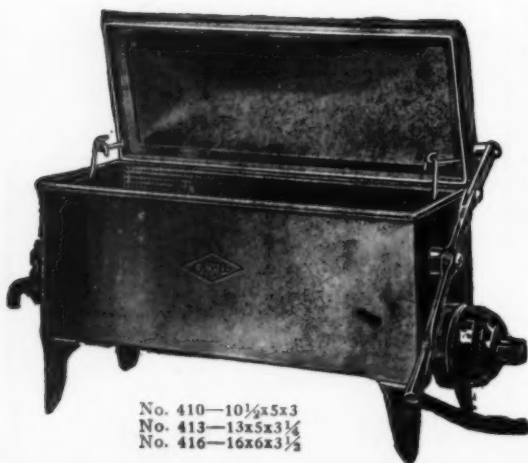
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